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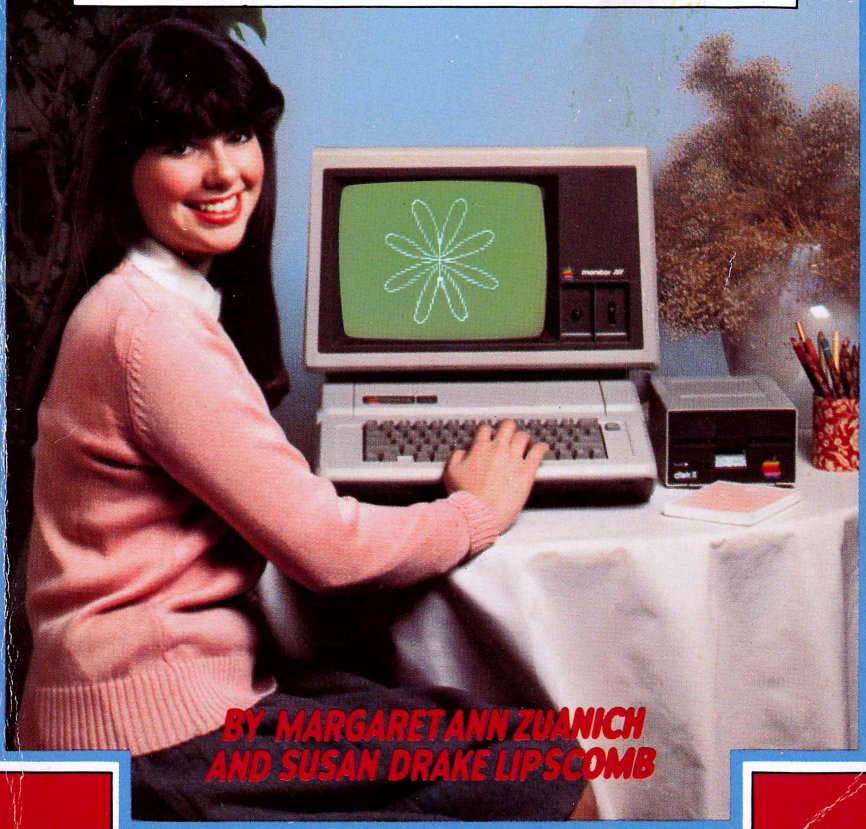
A guide to computer graphics

BASIC FUN WITH GRAPHICS THE APPLE® COMPUTER WAY



BY MARGARET ANN ZUANICH
AND SUSAN DRAKE LIPSCOMB

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MARGARET ANN ZUANICH and SUSAN DRAKE LIPSCOMB have a unique combination of skills that contributed to the creation of BASIC FUN WITH GRAPHICS. Margaret Zuanich's experience in the computer field has included everything from programming to management consulting. She earned her Master's Degree in Business and is now involved in computer systems training. Susan Lipscomb holds a Master's Degree in Education and has spent fourteen years in the area of language and learning disabilities.They both live in Palo Alto, California.

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BASIC FUN WITH GRAPHICS THE APPLE® COMPUTER WAY

MARGARET ANN ZUANICH
AND SUSAN DRAKE LIPSCOMB

AN AVON CAMELOT BOOK

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INTRODUCTION

Are you ready for the fun and challenge of graphics programming? Do you want to use your computer to create your own pictures and designs, move objects around on the screen, or design your own video game? *BASIC Fun With Graphics* gets you started using the graphics programming statements on your computer. Each chapter includes exercises that show how the graphics statements work and simple BASIC programs that demonstrate exciting and fun ways to use these statements.

BASIC Fun With Graphics presents a systematic yet entertaining approach to learning graphics programming. First you type in the exercises and programs exactly as they appear in the book. Then you experiment and change them, using your own ideas. Finally, you create your own designs and pictures, using those in the book as a guide.

BASIC Fun With Graphics covers the beginning and intermediate graphics statements available in Applesoft BASIC, as well as a chapter for "hotshots" that uses higher-level mathematical functions to rotate geometric figures and generate new and unique designs. It stops short of commands that directly address memory, like PEEK and POKE statements and shape tables used in sophisticated graphics and animation. When you're ready for this level of programming, your computer's BASIC reference guide has a comprehensive discussion of how to proceed.

BASIC Fun With Graphics is written in Applesoft BASIC for the Apple II, Apple II Plus, and Apple IIe computers. The programs will run on either a color or monochrome monitor. For visual appeal, COLOR statements are included in all the programs. These colors will appear as different shades on a monochrome monitor.

We've found that experimenting with the graphics state-

ments and creating designs and pictures on the screen was great fun. We hope you get as many "oohs," "aaahs," and chuckles as we have.

HOW TO USE BASIC FUN WITH GRAPHICS

1. Start up your Apple and type NEW.

2. Type in each program as shown in the Program Listing. For programming statements that require more than one line in the listing, type in the entire line before hitting RETURN.

3. Once you have a program entered into your computer, type RUN and press Return. The computer will run your program and display the results on the screen. It should look like the example in the book.

4. To check the programming statements, type LIST and press Return. The computer will list your program.

5. Now try making the changes suggested in the text or experimenting with other variations, using our programs as a guide.

6. When you're ready to save your program, use the SAVE command. To retrieve a program from the disk, use the LOAD command.

7. Before you enter another program, type New to erase anything currently in memory.

8. The Warm-up Exercises at the beginning of each chapter contain explanations of each graphics statement, and examples, using each graphics statement. Read these and work through the exercises before you proceed to the programs.

9. The pictures used as examples in this book were drawn using the screen display as a guide. The actual display on your screen may vary slightly from these examples.

10. If you have difficulties making a program work, check your program line by line against the listing in the book. All of the programs were tested on an Apple II Plus and an Apple IIe.

BASIC FUN WITH GRAPHICS THE APPLE® COMPUTER WAY

1 PRINT

Use this program statement to tell the computer what to print on the screen or paper.

PROGRAMS

1. Warm-ups
2. House
3. Ocean Liner
4. Space Fleet
5. Bugs
6. Rocket Ship
7. Bicycle

WARM-UPS

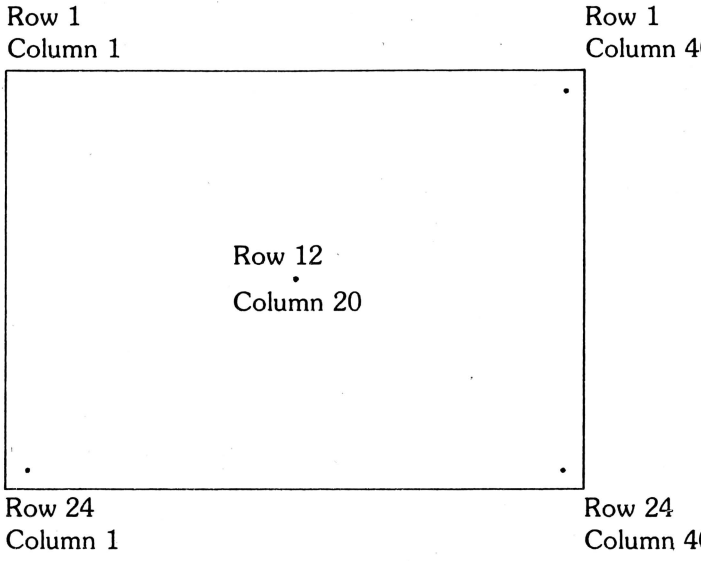
The format for the PRINT programming statement is:

PRINT "

You can use any combination of letters, numbers, and special characters in a PRINT statement.

Your computer has three display modes: Text, Low-Resolution graphics, and High-Resolution graphics. This chapter shows you how to use the Text mode to draw shapes and objects.

In Text mode, you have 24 rows and 40 columns. (Or 80 if the 80-column text card is installed and running.) The rows are numbered from top to bottom, the columns from left to right. If you think of your screen as a piece of graph paper, then the top left square is Row 1, Column 1 and the bottom right square is Row 24, Column 40 or Row 24, Column 80 with the 80-column card.



The TEXT statement instructs Applesoft to begin displaying text and moves the cursor to the bottom left corner of the screen.

The HOME statement clears the currently defined text window screen and sends the cursor to the top left corner of the window.

HOUSE

Use PRINT to draw a house. Put this program in your computer by typing each line exactly as shown in the Program Listing.

Once you have this program up and running, try adding a chimney or another window.

```
     /XXXXXXXXXXXXXXX
    /   XXXXXXXXXXXXXXX
   /        XXXXXXXXXXXXX
  /           XXXXXXXXXXXX
 /              XXXXXXXXXXXX
/    _    _       XXXXXXXXXXX
I   I_I  I_I      I           I
I                  I     __    I
I     ____         I    I__I   I
I     I  I         I           I
I_____I  I________I___________I
```

PROGRAM LISTING

```
100  PRINT "     /XXXXXXXXXXXXXXX"
110  PRINT "    /   XXXXXXXXXXXXXXX"
120  PRINT "   /        XXXXXXXXXXXXX"
130  PRINT "  /           XXXXXXXXXXXX"
140  PRINT "/    _    _       XXXXXXXXXXX"
150  PRINT "I   I_I  I_I      I           I"
160  PRINT "I                 I     __    I"
170  PRINT "I     ____        I    I__I   I"
180  PRINT "I     I  I        I           I"
190  PRINT "I_____I  I________I___________I"
```

NOTE

Lines 100-190: When the programs runs, the PRINT statement tells the computer to print out everything between the two " marks on each line, exactly as it is shown in the program.

OCEAN LINER

Draw an ocean liner with this program.
Now add some portholes or another deck to make your own ship.

```
          ____
        __!  !_______
       _!____________!__
_______!__________________!_______
\ O     O           O      O /
 \_____________________________/
```

PROGRAM LISTING

```
100  PRINT "          ____"
110  PRINT "        __!  !_______"
120  PRINT "       _!____________!__"
140  PRINT "_______!__________________!_______"
150  PRINT "\ O     O           O      O /"
160  PRINT " \_____________________________/"
```

NOTE

Lines 150, 160: Since the Apple II does not have the \ (backward slash) key, substitute another symbol such as the I or the (.

SPACE FLEET

Create a fleet of different kinds of spacecraft.

```
          *
         <_>

   _
-<_>-

         +
        / \
      -     -
        \_/

  ^
 ! !
 ! !
/ \

          /\
          !!
          !!
          !!
          /\

             @@@@
           /######\
          !********!
             ^^^^
```

PROGRAM LISTING

```
100  PRINT "          *"
110  PRINT "         <_>"
120  PRINT "   _"
130  PRINT "-<_>-"
140  PRINT "         +"
150  PRINT "        / \"
160  PRINT "      -    -"
170  PRINT "        \_/"
180  PRINT "  ^"
```

```
190  PRINT " ! !"
200  PRINT " ! !"
210  PRINT " / \"
220  PRINT "            /\"
230  PRINT "            !!"
240  PRINT "            !! "
250  PRINT "            !!"
260  PRINT "            /\"
270  PRINT "                @@@@"
280  PRINT "              /######\"
290  PRINT "             !********!"
300  PRINT "                ^^^^"
```

NOTE

You can use any of the special characters on the keyboard in a PRINT statement. Experiment with these characters and make some of your own spaceships.

BUGS

Here is a swarm of bugs.
Can you come up with some species of your own?

```
   \/
  (__)
   ,,
        !!
       /  \
        \/
  +
\( )/
/( )\
 /*\
        ^  ,,  ^
       / \()/  \
       \ /   \ /
        +     +
 \__/
 (..)
///\\\
       #@@@@@@@@@@
        !!!!!!!!!!
```

PROGRAM LISTING

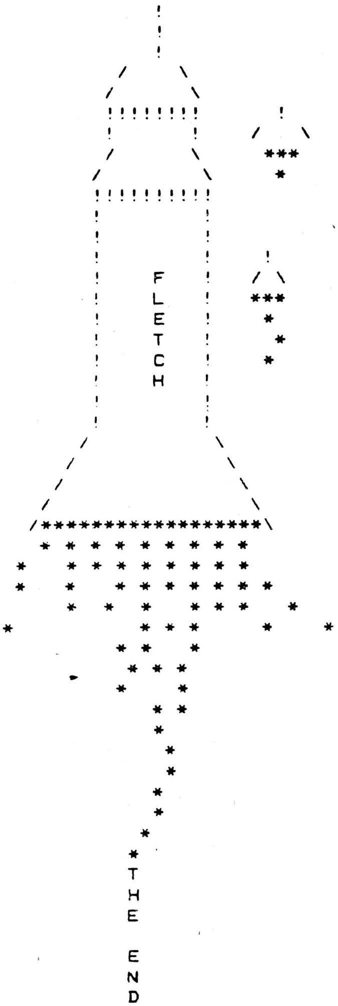
```
100  PRINT "     \/"
110  PRINT "    (__)"
120  PRINT "     ,,"
130  PRINT "          !!"
140  PRINT "         /  \"
150  PRINT "          \/"
160  PRINT "    +"
170  PRINT " \( )/"
180  PRINT " /( )\"
190  PRINT "  /*\"
```

```
200  PRINT "          ^  ,,  ^"
210  PRINT "        / \()/  \"
220  PRINT "        \ /   \  /"
230  PRINT "         +     +"
240  PRINT "   \__/"
250  PRINT "   (..)"
260  PRINT " ///\\\"
270  PRINT "        #@@@@@@@@@@"
280  PRINT "         !!!!!!!!!!"
```

ROCKET SHIP

This rocket is drawn by the computer and then blasts off the screen, leaving a trail of fire.

You can do the same thing with your own spaceships.



PROGRAM LISTING

```
100  PRINT "                !"
110  PRINT "                !"
120  PRINT "                !"
130  PRINT "            /     \  "
140  PRINT "           /       \"
150  PRINT "           !!!!!!!!        !"
160  PRINT "           !       !     /   \"
170  PRINT "           /       \      ***"
180  PRINT "         /           \      *"
190  PRINT "         !!!!!!!!!!"
200  PRINT "         !         !"
210  PRINT "         !         !"
220  PRINT "         !         !     !"
230  PRINT "         !    F    !    / \"
240  PRINT "         !    L    !    ***"
250  PRINT "         !    E    !     *"
260  PRINT "         !    T    !      *"
270  PRINT "         !    C    !     *"
280  PRINT "         !    H    !"
290  PRINT "         !         !"
300  PRINT "         !         !"
310  PRINT "        /           \"
320  PRINT "       /             \"
330  PRINT "      /               \"
340  PRINT "     /                 \"
350  PRINT "    /******************\"
360  PRINT "     * * * * * * * * * *"
370  PRINT "  *   * * * * * * * * *"
380  PRINT "  *   *   * * * * * * *"
390  PRINT "      *  *  *   * * *   *"
400  PRINT " *           * * *     *    *"
410  PRINT "            * *   *"
420  PRINT "             * * *"
430  PRINT "            *    *"
440  PRINT "               * *"
450  PRINT "               *"
460  PRINT "                *"
470  PRINT "                *"
480  PRINT "               *"
490  PRINT "               *"
500  PRINT "              *"
510  PRINT "             *"
520  PRINT "             T"
530  PRINT "             H"
540  PRINT "             E"
550  PRINT "              "
560  PRINT "             E"
570  PRINT "             N"
580  PRINT "             D"
590  FOR X = 1 TO 40
600  PRINT
610  NEXT X
```

NOTE

Lines 590-610: This is a FOR . . . NEXT loop, which allows you to

repeat part of your program as many times as you want. The FOR statement begins the loop, and the NEXT statement ends it. In this program it repeats Line 600, which PRINTs a blank line 40 times, making the rocket move up the screen so it appears to blast off.

BICYCLE

Now you can create a ten-speed bicycle.
Can you design a racer or dirt bike of your own?

```
  I---"
   \              _______"
    ^            _____+ &"
  _-+-_\_       /    _---_"
 -  I   - \_   /   -  I   -"
-   I    -   \/ =_    I    _"
_____+_____   I/  _____+_____"
_   I     _  (X)  _  ==I    _"
 _  I    _ /   -===-_ I   _"
  -_I_-   =          -_I_-"
```

PROGRAM LISTING

```
100 HOME
110 PRINT "   I---"
120 PRINT "    \              _______"
130 PRINT "     ^            _____+ &"
140 PRINT "   _-+-_\_       /    _---_"
150 PRINT " -  I   - \_   /   -  I   -"
160 PRINT "-   I    -   \/ =_    I    _"
170 PRINT "_____+_____   I/  _____+_____"
180 PRINT "_   I     _  (X)  _  ==I    _"
190 PRINT "  _ I    _ /   -===-_ I   _"
200 PRINT "   -_I_-   =          -_I_-"
```

2 VTAB and HTAB

The VTAB and HTAB statements tell the computer the row and column where characters are to PRINT.

PROGRAMS

1. Warm-ups
2. Face
3. Christmas Lights
4. Candy Jar
5. Tower
6. Hide-and-Seek

The formats are:

VTAB Y where Y represents row position 1 through 24
HTAB X where X represents column position 1 through 40

VTAB and HTAB are used together to set the print position at any row and column. The cursor shows that location on the screen.

EXERCISE 1

Use VTAB and HTAB to put a character at various locations on your screen.

```
                    *

10 VTAB 12:  HTAB 20
20 PRINT "*"
```

This exercise puts an * at location row 12, column 20. Try placing the * at other locations on the screen.

FACE

Draw a girl's face and then add features. You can change her expression by altering Lines 210, 230, and 270.

```
  //////
::      ::
::  ^ ^ ::
::  O O ::
::      ::
::    ^ ::
::    - ::
::  --- ::
::      ::
```

PROGRAM LISTING

```
100  HOME
110  PRINT "      //////"
120  PRINT "    ::      ::"
130  PRINT "    ::      ::"
140  PRINT "    ::      ::"
150  PRINT "    ::      ::"
160  PRINT "    ::      ::"
170  PRINT "    ::      ::"
180  PRINT "    ::  ---  ::"
190  PRINT "    ::      ::"
200  VTAB 3: HTAB 7
210  PRINT "^ ^"
220  VTAB 4: HTAB 7
230  PRINT "O O"
240  VTAB 6: HTAB 8
250  PRINT "^"
260  VTAB 7: HTAB 8
270  PRINT "-"
280  VTAB 15
```

NOTES

Line 200: VTAB 3 tells the computer to move the print position to row 3. HTAB 7 tells the computer to start PRINTing at column 7 on that same row.

Line 280: VTAB 15 puts the cursor below the bottom of the picture at row 15. Otherwise, the cursor appears immediately below the last line printed, in this case the mouth.

CHRISTMAS LIGHTS

Draw a Christmas tree, then go back and decorate it. Add ornaments of your own to the program.

```
              *
             * *
            *   *
           *  !  *
          *       *
         *         *
        *  *     *  *
       *             *
      *               *
    *   !  @ @ @  !   *
  *                     *
---------:  :---------
          :  :
```

PROGRAM LISTING

```
100  HOME
110  PRINT
120  FOR L = 1 TO 10
130  PRINT  TAB( 20 - L);"*"; TAB(
     20 + L);"*"
140  NEXT L
150  FOR L = 1 TO 21
160  PRINT  TAB( 9 + L);"-";
170  NEXT L
180  VTAB 12: HTAB 19
190  PRINT ";  :"
200  VTAB 13: HTAB 19
210  PRINT ";  :"
220  REM ** DECORATE TREE
```

```
230  GOSUB 360
240  VTAB 1: HTAB 20
250  PRINT "*"
260  GOSUB 360
270  VTAB 4: HTAB 20
280  PRINT "!"
290  GOSUB 360
300  VTAB 7: HTAB 17
310  PRINT "*      *"
320  GOSUB 360
330  VTAB 10: HTAB 14
340  PRINT " !  @ @ @  !"
350  GOTO 390
360  FOR W = 1 TO 400
370  NEXT W
380  RETURN
390  VTAB 18
400  END
```

NOTES

Line 130: The TAB statement allows you to tell the computer the column in which you want to start PRINTing. In this case, the first time through the loop, the computer will print * in column 19 (20-1) and * in column 21 (20+1). The second time * will print in column 18 (20-2) and * in column 22 (20+2), and so on.

Line 220: The REM statement allows you to put remarks in the program listing.

Line 230: GOSUB tells the computer to leave the program and go to a subroutine, in this case Line 360.

Line 350: GOTO tells the computer to go to a designated line number, in this case Line 390.

Lines 360-380: Subroutines are small programs within a larger program that are used over and over. When the subroutine is finished, a RETURN statement tells the computer to go back to where it came

from in the main program. Here the subroutine is a Wait Loop that simply makes the computer pause before it continues to decorate the tree.

Line 390: This line positions the cursor below the picture at row 18.

Line 400: The END statement tells the computer that it is the last line in the program. It stops the Run.

CANDY JAR

This program draws a candy jar and fills it with jelly beans. Design your own container and fill it with marbles.

```
  ----
  :   :
  :   :
 *     *
:000000:
:000000:
:000000:
:000000:
:------:
```

PROGRAM LISTING

```
100  HOME
110  VTAB 7
120  PRINT "      ----"
130  PRINT "      :   :"
140  PRINT "      :   :"
150  PRINT "    *     *"
160  PRINT "   :       :"
170  PRINT "   :       :"
180  PRINT "   :       :"
190  PRINT "   :       :"
200  PRINT "   :------:"
210  FOR Y = 14 TO 11 STEP  - 1
220  FOR X = 5 TO 10
230  VTAB Y: HTAB X
240  PRINT "O";
250  NEXT X
260  FOR T = 1 TO 200: NEXT T
270  NEXT Y
280  VTAB 18
```

NOTE

Lines 210-270: These lines form two nested FOR . . . NEXT loops, to fill the jar from the bottom up. The Y loop sets the rows and the X loop sets the columns to print the O.

TOWER

Build a tower, using one of the Apple's special characters.

Can you change the program to build a pyramid, using a different character?

```
###
###
###
###
###
###
###
###
###
```

PROGRAM LISTING

```
100  HOME
110  FOR J = 24 TO 15 STEP  - 1
120  FOR I = 19 TO 21
130  VTAB J: HTAB I
140  PRINT "#"
150  NEXT I
160  NEXT J
170  VTAB 1
```

NOTES

Line 170: VTAB 1 positions the cursor above the picture at row 1.

HIDE-AND-SEEK

Here's a hide-and-seek game you play with the computer. Guess which tree X is hiding behind, and the computer will show you if you're right.

```
      ^                    ^
     *4*                  *1*
     -:-                  -:-
                  ^
                 *3*
                 -:-
  ^                    ^
 *5*                  *2*
 -:-                  -:-
```

```
WHERE IS X HIDING?
BEHIND TREE 1,2,3,4 OR 5?
```

PROGRAM LISTING

```
100  HOME
110 A =  INT ( RND (1) * 5 + 1)
120  FOR L = 1 TO 5
130 X =  INT ( RND (1) * 35 + 1)
140 Y =  INT ( RND (1) * 15 + 1)
150  VTAB Y: HTAB X
160  PRINT " ^"
170  VTAB (Y + 1): HTAB X
180  PRINT "*";L;"*"
190  VTAB (Y + 2): HTAB X
200  PRINT "-:-"
210  IF A = L THEN 240
```

```
220  NEXT L
230  GOTO 260
240 X1 = X + 3:Y1 = Y + 2
250  GOTO 220
260  VTAB 20: HTAB 1
270  PRINT "WHERE IS X HIDING?"
280  PRINT "BEHIND TREE 1,2,3,4 O
     R 5";
290  INPUT N
300  IF A = N THEN 350
310  PRINT "SORRY...BEHIND TREE "
     ;A;"!"
320  PRINT "YOU'RE STILL 'IT'!"
330  FOR K = 1 TO 1000: NEXT K
340  GOTO 100
350  PRINT "YOU'RE RIGHT!!!"
360  PRINT "THERE HE IS!"
370  VTAB Y1: HTAB X1
380  PRINT "X"
390  VTAB 24: HTAB 1
400  PRINT "WANT TO PLAY AGAIN (Y
      OR N)";
410  INPUT N$
420  IF N$ = "Y" THEN 100
430  END
```

NOTES

Lines 110, 130, 140: RND(1) is a random-number function which generates random numbers from 0 to .9999. INT is an integer function which changes decimal numbers to whole numbers by dropping the fractional part of the number. The statement A = INT (RND(1) * 5 + 1) tells the computer "Let A be a random number between 1 and 5."

Lines 290, 410: The INPUT programming statement allows you to enter different numbers or words into your program each time it runs.

Lines 210, 300, 420: The IF . . . THEN programming statement makes the computer decide which line number to execute next. IF the condition is true, THEN the program goes to the line number indicated. Otherwise it goes to the following line number.

3 LOW-RESOLUTION GRAPHICS

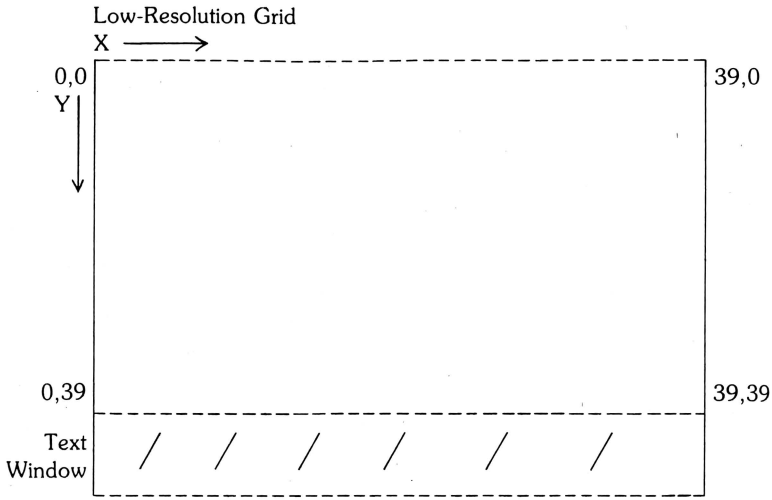
The graphics commands HLIN, VLIN, PLOT, COLOR, and GR are used to create graphics in Low-Resolution graphics mode.

PROGRAMS

1. Warm-ups
2. Christmas Tree
3. House
4. Flag
5. Sailboat
6. Picture

WARM-UPS

Now you are ready to explore the graphics capabilities of your computer. The programs and exercises included in this chapter use the Low-Resolution graphics mode. This mode uses a grid 40 columns across and 40 rows down, with 16 color options and 4 lines of text at the bottom of the screen. If you think of the screen as an X,Y axis, then X corresponds to the columns and Y to the rows. The top left point on the screen is (0,0) and the bottom right is (39,39). X increases as you move to the right across the screen, and Y increases as you move down.



GR

The GR graphics statement tells the computer to display Low-Resolution graphics. The screen is cleared to black and the text cursor is moved to the bottom line. This statement is normally the first statement in a Low-Resolution, or Lo-Res, graphics program.

The command GR puts your computer into the Low-Resolution mode. Once you type this in, you will stay in GR until you do a Control Reset or type TEXT.

COLOR

The COLOR statement sets the color for plotting Lo-Res graphics. There are 16 colors available, represented by numbers 0 to 15, as follows:

0	Black	8	Brown
1	Magenta	9	Orange
2	Dark Blue	10	Gray-2
3	Violet	11	Pink
4	Dark Green	12	Green
5	Gray-1	13	Yellow
6	Medium Blue	14	Aqua
7	Light Blue	15	White

The format for the COLOR statement is:

COLOR = n where n is a number from 0 to 15

The Lo-Res graphics statements following a COLOR statement will use the color specified until a new COLOR statement is executed.

If you are using a monochrome display, the different colors will appear as various patterns of shading.

PLOT

The PLOT graphics statement places a block of the current display color at a specified location on the screen. The format is:

PLOT X1, Y1

X1: X coordinate (or column) of the location to plot
Y1: Y coordinate (or row) of location to plot

HLIN

The HLIN graphics statement draws a horizontal line, using the current display color on the screen. The format is:

HLIN X1, X2 at Y1

X1: X coordinate to start drawing line
X2: X coordinate to end line
Y1: Y coordinate to draw line on

VLIN

The VLIN graphics statement draws a vertical line, using the current display color on the screen. The format is:

VLIN Y1, Y2 at X1

Y1: Y coordinate to start drawing line
Y2: Y coordinate to end line
X1: X coordinate to draw line on

EXERCISE 1

Use PLOT in the immediate mode to place a square in the middle of the screen.

```
GR
COLOR =3
PLOT 20,20
```

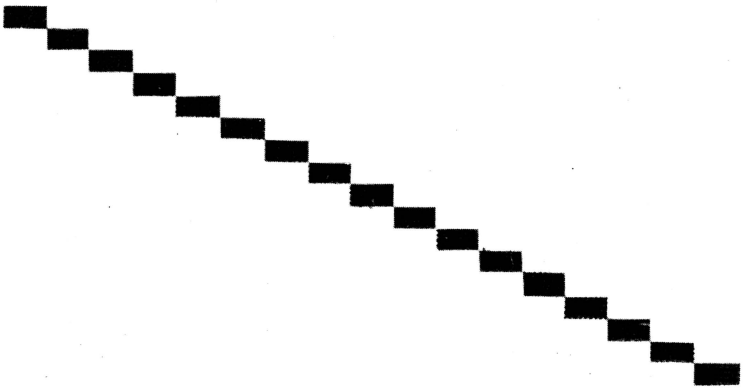
This example uses color 3 for the point. Try different colors by changing the COLOR statement.

To erase this point, use COLOR = 0.

```
COLOR=0
PLOT 20,20
```

EXERCISE 2

Use PLOT to draw a diagonal across the screen.



```
10  GR
20  COLOR= 3
30  FOR X = 1 TO 39
40 Y = X
50  PLOT X,Y
60  NEXT X
```

Can you change the program to draw the diagonal in the opposite direction?

```
30  FOR X = 39 TO 1 STEP  - 1
40 Y = 39 - X
```

EXERCISE 3

Draw a line using HLIN.

```
10   GR
20   COLOR= 2
30   HLIN 1,20 AT 10
```

EXERCISE 4

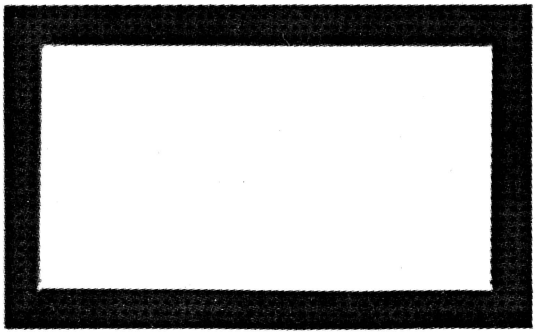
Use the VLIN statement to draw a vertical line on the screen.

```
10   GR
20   COLOR= 2
30   VLIN 1,20 AT 10
```

Try different values in VLIN and see where your lines end up.

EXERCISE 5

Use the VLIN and HLIN statements to draw a box.

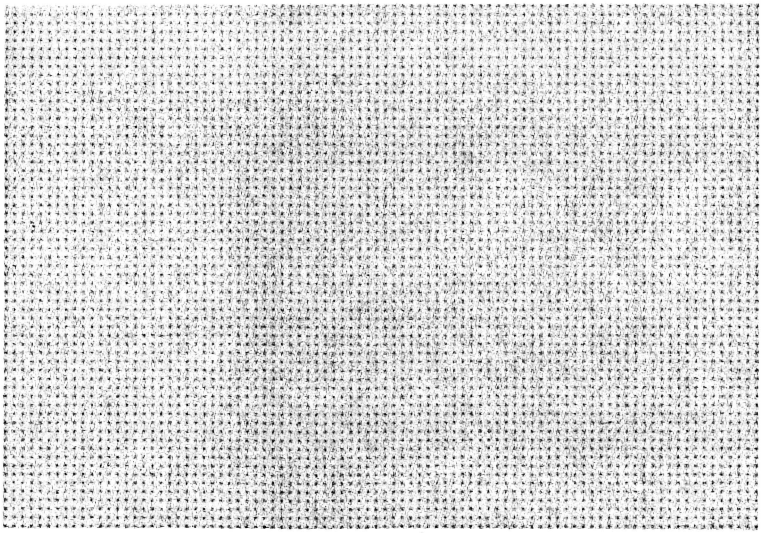


```
10  GR
20  COLOR= 4
30  HLIN 10,30 AT 15
40  HLIN 10,30 AT 35
50  VLIN 15,35 AT 10
60  VLIN 15,35 AT 30
```

Experiment with different X, Y coordinates for the corners and see what your boxes look like.

EXERCISE 6

Use HLIN and VLIN to fill your screen with color.



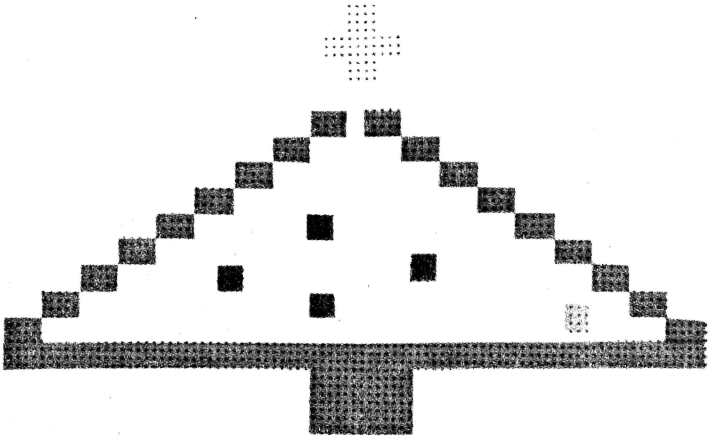
```
10   GR
20   COLOR= 6
30   FOR I = 0 TO 39
40   HLIN 0,39 AT I
50   NEXT I
```

This is useful for backgrounds in your Lo-Res pictures.

Now change the number used in Line 20 and try the other colors in Lo-Res.

CHRISTMAS TREE

Use this program to draw a Christmas tree and put on some lights. Add some more lights to the tree once you get this program up and running.



PROGRAM LISTING

```
100  GR : HOME : COLOR= 4
110  FOR X = 5 TO 16
120  REM  DRAW TREE
130 Y =  - 1.5 * X + 25
140  PLOT X,Y
150  NEXT X
160  FOR X = 16 TO 28
170 Y = 1.5 * X - 24
180  PLOT X,Y
190  NEXT X
200  REM  DRAW TRUNK
210  HLIN 5,27 AT 18
220  VLIN 18,24 AT 15
230  VLIN 18,24 AT 16
```

```
240  VLIN 18,24 AT 17
250  REM  DRAW LIGHTS
260  COLOR= 1: PLOT 10,15
270  COLOR= 1: PLOT 20,12
280  COLOR= 9: PLOT 15,10
290  COLOR= 9: PLOT 26,16
300  COLOR= 13: PLOT 16,16
310  REM  DRAW STAR ON TOP
320  COLOR= 15
330  HLIN 15,17 AT 1
340  VLIN 0,2 AT 16
```

NOTES

Line 100: GR puts the computer in Lo-Res graphics mode. COLOR = 4 sets the display color to dark green.

Lines 110-150, 160-190: Put blocks of color on a diagonal line.

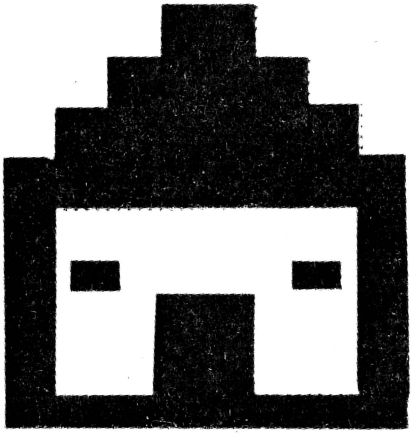
Lines 200-240: Draw the tree trunk.

Lines 260-300: Put blocks of color inside the tree for the lights. The COLOR = statement sets the color, and PLOT displays the block of color.

Lines 320-340: Draw the star on top of the tree.

HOUSE

Here is a small house. See if you can add windows or a chimney.



PROGRAM LISTING

```
100  GR
110  COLOR= 8
120  VLIN 35,25 AT 18
130  VLIN 35,25 AT 29
140  HLIN 18,29 AT 25
150  HLIN 18,29 AT 35
160 I = 0
170  FOR Y = 25 TO 20 STEP  - 1
180  HLIN 18 + I,29 - I AT Y
190 I = I + 1
200  NEXT Y
210  HLIN 21,22 AT 27: HLIN 25,26
      AT 27
220  HLIN 21,22 AT 28: HLIN 25,26
      AT 28
230  VLIN 30,35 AT 23: VLIN 30,35
      AT 24
```

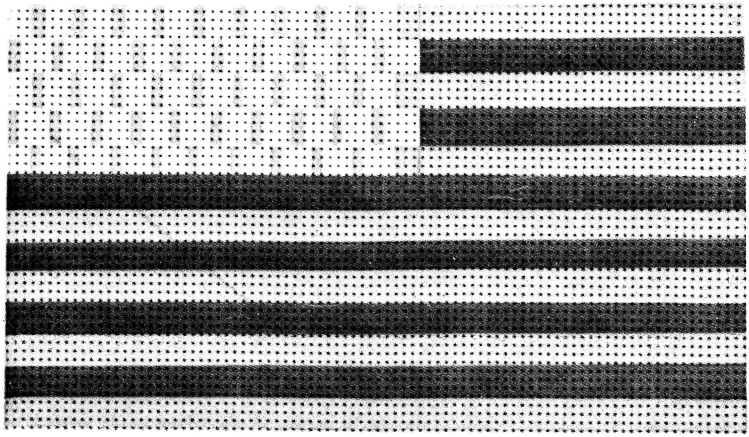
NOTES

Lines 120-150: Draw the house by making a box with VLIN and HLIN.

Lines 170-200: Make the roof by drawing lines with HLIN that get shorter and shorter.

FLAG

This program draws a flag with 50 stars and 13 stripes. Can you change it to draw another flag?



PROGRAM LISTING

```
100  HOME : GR
110  COLOR= 3
120  FOR Y = 38 TO 26 STEP  - 4
130  HLIN 0,38 AT Y
140  HLIN 0,38 AT Y + 1
150  NEXT Y
160  COLOR= 2
170  FOR Y = 36 TO 22 STEP  - 4
180  HLIN 0,38 AT Y
190  HLIN 0,38 AT Y + 1
200  NEXT Y
210  COLOR= 3
220  FOR Y = 22 TO 14 STEP  - 4
230  HLIN 20,38 AT Y
240  HLIN 20,38 AT Y + 1
```

```
250  NEXT Y
260  COLOR= 2
270  FOR Y = 20 TO 16 STEP  - 4
280  HLIN 20,38 AT Y
290  HLIN 20,38 AT Y + 1
300  NEXT Y
310  COLOR= 3
320  FOR Y = 14 TO 23
330  HLIN 0,19 AT Y
340  NEXT Y
350  COLOR= 2
360  FOR X = 0 TO 19 STEP 2
370  FOR Y = 14 TO 23 STEP 2
380  PLOT X,Y
390  NEXT Y
400  NEXT X
```

NOTES

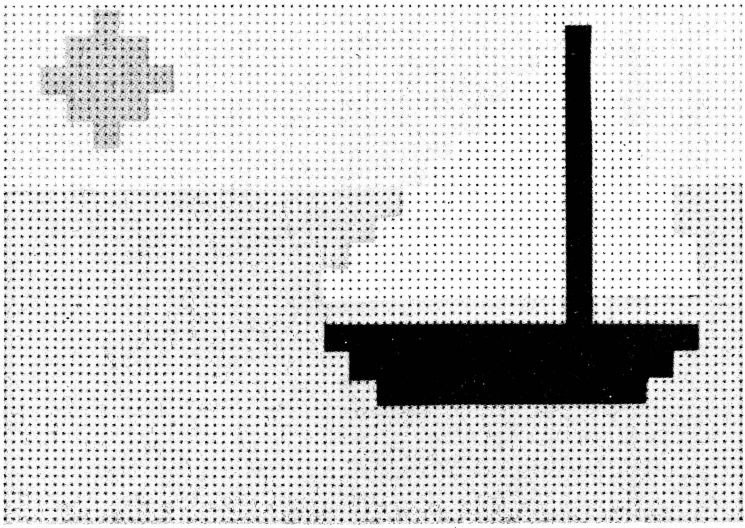
Lines 120-150: This FOR . . . NEXT loop draws 4 magenta lines, leaving space between lines.

Lines 170-200: This FOR . . . NEXT loop draws 4 dark-blue horizontal lines in the spaces between the magenta lines.

Lines 360-400: These nested FOR . . . NEXT loops draw the 50 blocks of color for the stars.

SAILBOAT

Draw a picture of a sailboat.
Can you add some sea gulls to the picture?



PROGRAM LISTING

```
100  GR : HOME
110  COLOR= 7
120  REM  FILL IN SKY
130  FOR Y = 1 TO 15
140  HLIN 1,39 AT Y
150  NEXT Y
160  REM  FILL IN SEA
170  COLOR= 6
180  FOR Y = 16 TO 39
190  HLIN 1,39 AT Y
200  NEXT Y
210  REM  DRAW HULL OF BOAT
```

```
220  COLOR= 8
230  HLIN 20,35 AT 22
240  HLIN 21,34 AT 23
250  HLIN 22,33 AT 24
260  REM  DRAW SAIL
270  COLOR= 15:K = 0
280  FOR X = 20 TO 30
290 X1 = X + 15 - 1.5 * K
300  HLIN X,X1 AT 20 - K
310 K = K + 1
320  NEXT X
330  PLOT 29,7
340  REM  DRAW MAST
350  COLOR= 8
360  VLIN 8,21 AT 30
370  REM  DRAW SUN
380  COLOR= 13
390  VLIN 4,8 AT 6
400  HLIN 4,8 AT 6
410  VLIN 5,7 AT 5
420  VLIN 5,7 AT 7
```

NOTES

Lines 130-150: Fill in the sky with light blue by drawing a series of horizontal lines starting at row 1 through 15.

Lines 180-200: Fill in the sea with dark blue by drawing horizontal lines starting at row 16.

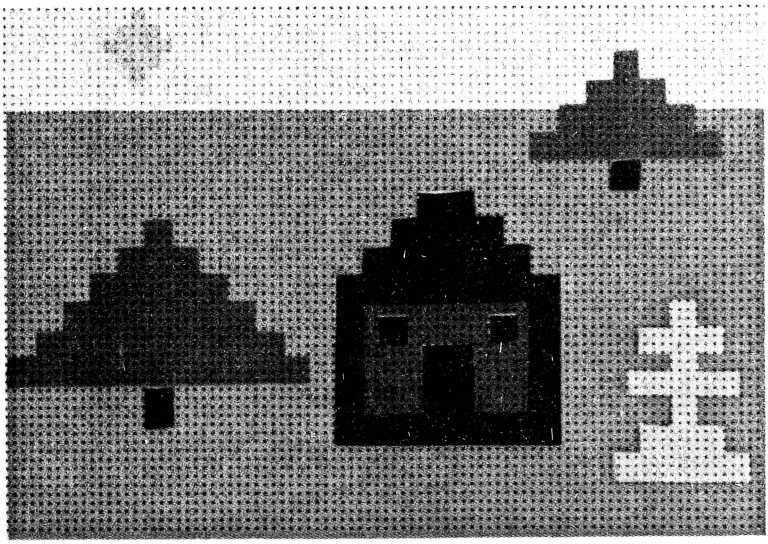
Lines 230-250: Draw the hull of the boat in brown. Notice that the brown of the boat covers the blue used for the sea.

Lines 280-320: Draw the sail in white.

Line 290: This arithmetic expression calculates the end of each line used to draw the sail, making it look like a triangle.

PICTURE

Draw this picture with your computer.
What additions can you make to the scene?



PROGRAM LISTING

```
100  GR : HOME
110  REM  FILL IN BACKGROUND WITH
       GREEN
120  COLOR= 12
130  FOR Y = 15 TO 39
140  HLIN 1,39 AT Y
150  NEXT Y
160  REM  FILL IN SKY WITH BLUE
170  COLOR= 7
180  FOR Y = 15 TO 1 STEP  - 1
190  HLIN 1,39 AT Y
200  NEXT Y
```

```
210  REM  TREES
220 YS = 13:YE = 16:X = 33
230  COLOR= 4
240  GOSUB 480
250  COLOR= 8: VLIN 17,19 AT 33
260 YS = 20:YE = 27:X = 7
270  GOSUB 480
280  COLOR= 8: VLIN 28,31 AT 7
290  REM  HOUSE
300  VLIN 35,25 AT 18
310  VLIN 35,25 AT 29
320  HLIN 18,29 AT 25
330  HLIN 18,29 AT 35
340 I = 0
350  FOR Y = 25 TO 20 STEP  - 1
360  HLIN 18 + I,29 - I AT Y
370 I = I + 1
380  NEXT Y
390  HLIN 21,22 AT 27: HLIN 25,26
      AT 27
400  HLIN 21,22 AT 28: HLIN 25,26
      AT 28
410  VLIN 30,35 AT 23: VLIN 30,35
      AT 24
420  REM  SUN
430  COLOR= 13
440  VLIN 4,8 AT 6: HLIN 4,8 AT 6

450  PLOT 5,5: PLOT 7,7: PLOT 5,7
     : PLOT 7,5
460  GOSUB 550
470  END
480  REM   DRAW TREE
490 I = 0: COLOR= 4
500  FOR Y = YS TO YE
510  HLIN X - I,X + I AT Y
520 I = I + 1
530  NEXT Y
```

```
540  RETURN
550  REM  DRAW FIGURE
560  COLOR= 11
570  VLIN 33,35 AT 34
580  PLOT 34,36: PLOT 33,37: PLOT
     35,37:
590  PLOT 32,38: PLOT 36,38
600  HLIN 32,36 AT 34
610  HLIN 33,35 AT 32
620  PLOT 34,31
```

NOTES

Lines 220-240, 250-270: Use a subroutine to draw the trees. The trees are placed in different locations by giving different values to YS, YE, and X.

Lines 350-380: Draw the roof of the house by making each line shorter.

4 HIGH-RESOLUTION GRAPHICS

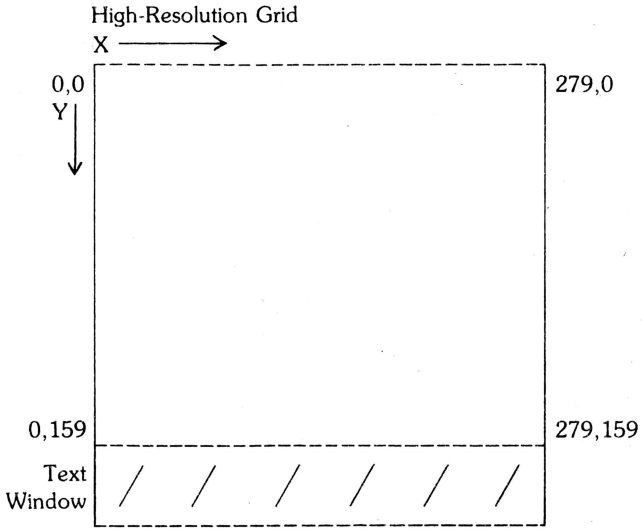
The graphics statements HGR, HCOLOR, and HPLOT are used to draw graphics in High-Resolution mode.

PROGRAMS

1. Warm-ups
2. Jet Plane
3. 3-D Room
4. Car
5. Fish
6. Skier
7. Snowflakes
8. Fishing Boat

WARM-UPS

High-Resolution graphics allows you to draw smaller, more detailed figures than are possible in Low Resolution. The screen has 280 points numbered 0-279 on the X axis and 160 points numbered 0-159 on the Y axis, with 4 lines of text at the bottom of the screen.



HGR

The statement HGR puts your computer in High-Resolution, or Hi-Res, graphics mode. Once you type this in, you will stay in HGR until you do a Control Reset or type TEXT.

HCOLOR

The HCOLOR statement sets the display color for Hi-Res graphics. There are 8 colors available, represented by numbers 0 to 7 as follows:

0	Black-1	4	Black-2
1	Green	5	Orange
2	Violet	6	Blue
3	White-1	7	White-2

The format for the HCOLOR statement is:

HCOLOR = n where n is a number from 0 to 7

HPLOT

The HPLOT graphics statement plots points and lines on the Hi-Res graphics screen in the current Hi-Res display color. The formats are:

1. HPLOT X1, Y1 Plots a point
X1: X coordinate of point to plot
Y1: Y coordinate of point to plot

2. HPLOT X1, Y1, to X2, Y2 Draws a line
X1, Y1: X,Y coordinates of starting point of the line
X2, Y2: X,Y coordinates of end point of the line

3. HPLOT to X2,Y2 Draws a line from last point plotted
X2,Y2: X,Y coordinates of end point of line to be plotted
The start of the line is last point plotted by HPLOT

4. HPLOT X1,Y1 to X2,Y2 to X3,Y3 . . . Draws a continuous figure
Each pair of X,Y coordinates gives the next point on the screen to use

EXERCISE 1

Use HPLOT in the immediate mode to draw a line in the middle of the screen.

```
HGR
HCOLOR=3
HPLOT 50,70 TO 80,70
```

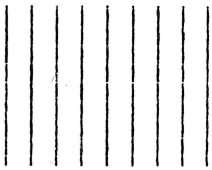
Notice that the line is much narrower than those drawn by HLIN in Lo-Res mode.

HPLOT is the only graphics command in Hi-Res mode. However, the different formats available with HPLOT allow you to draw many different designs and shapes.

Experiment with the different colors available in Hi-Res by changing the number used in the HCOLOR= line.

EXERCISE 2

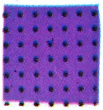
Draw a series of vertical lines on the screen.



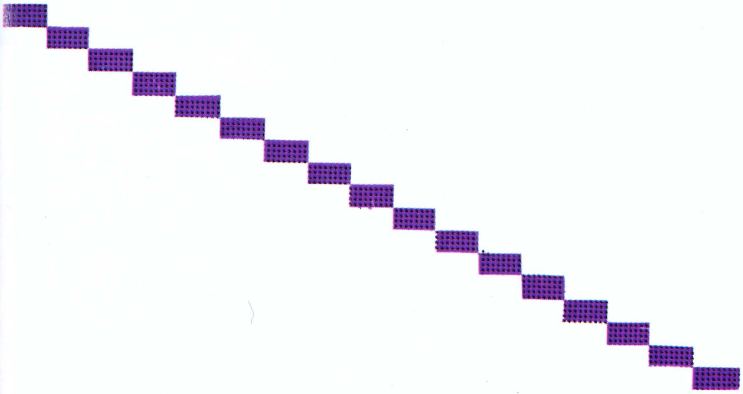
```
10   HGR
20   HCOLOR= 3
30   FOR X = 20 TO 90 STEP 8
40   HPLOT X,10 TO X,70
50   NEXT X
```

Now change the number in Line 20 and see how the different colors look. Notice that when you try to use No. 1 Green and No. 5 Orange, nothing shows on the screen. This is a result of the way the

GRAPHICS FROM CHAPTER THREE



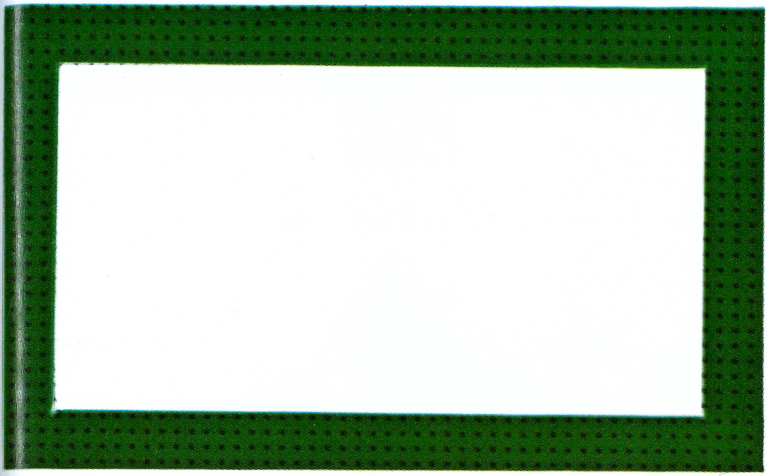
EXERCISE 1



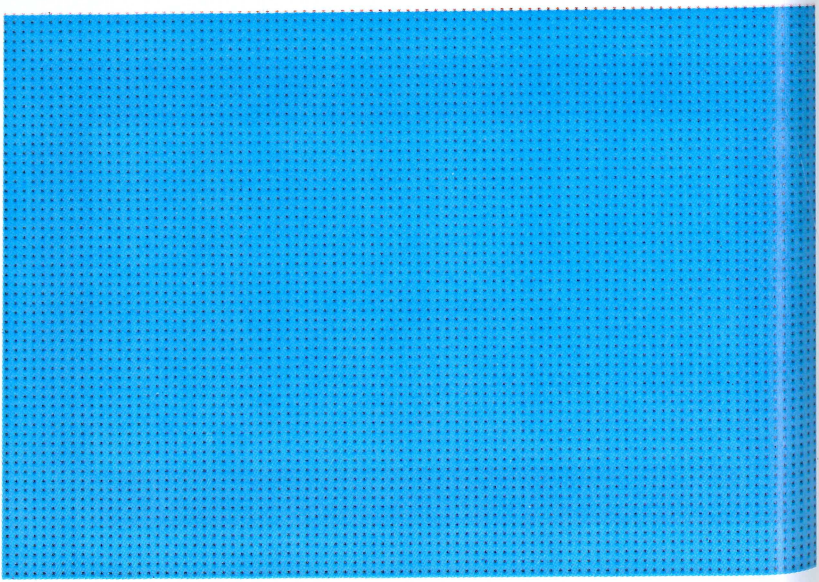
EXERCISE 2

EXERCISE 3

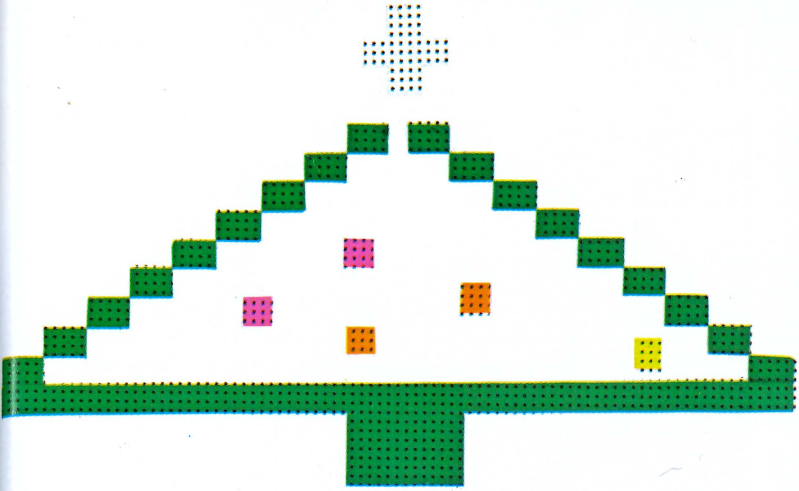
EXERCISE 4



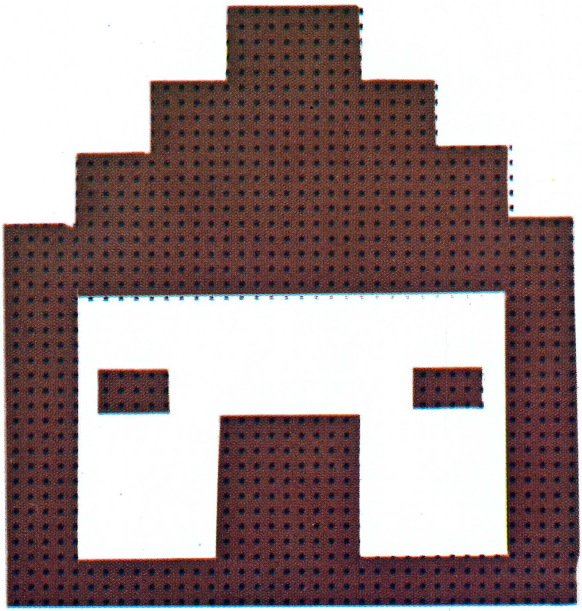
EXERCISE 5

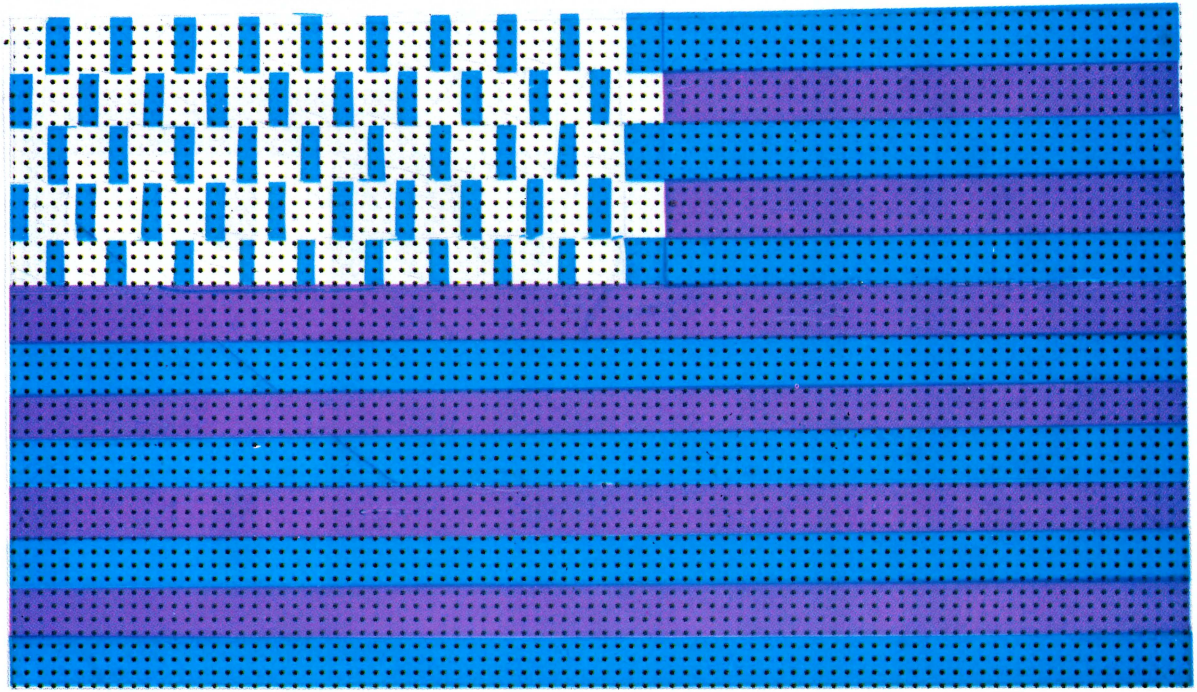


EXERCISE 6

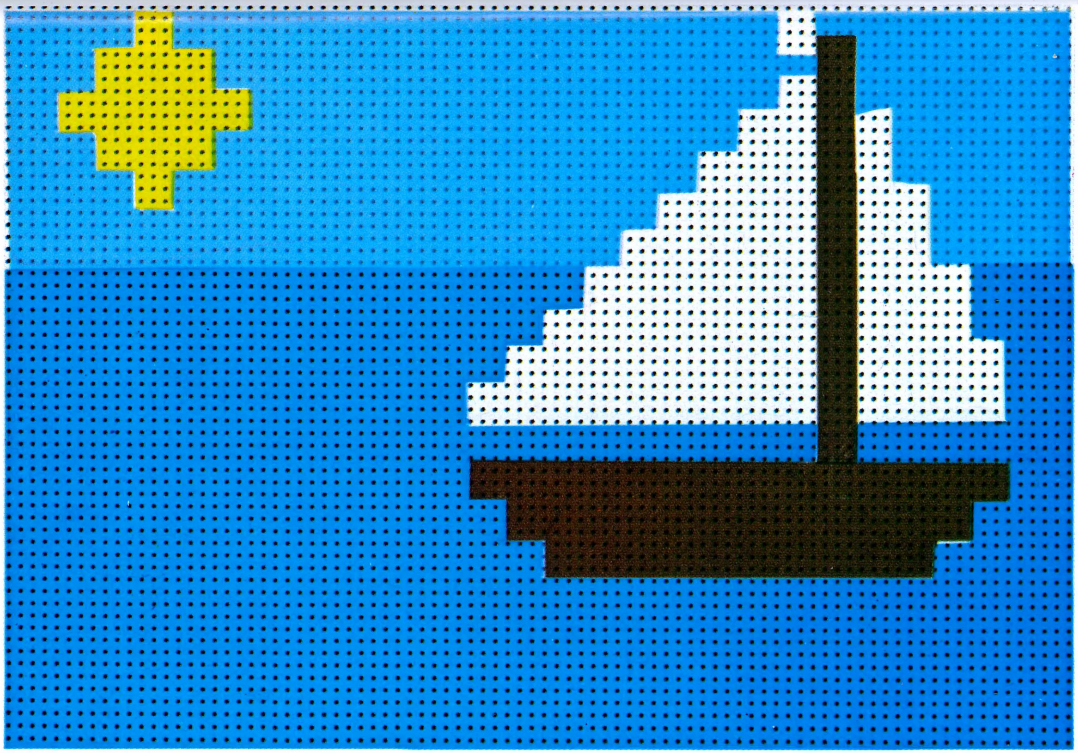


CHRISTMAS TREE—*Page 49*

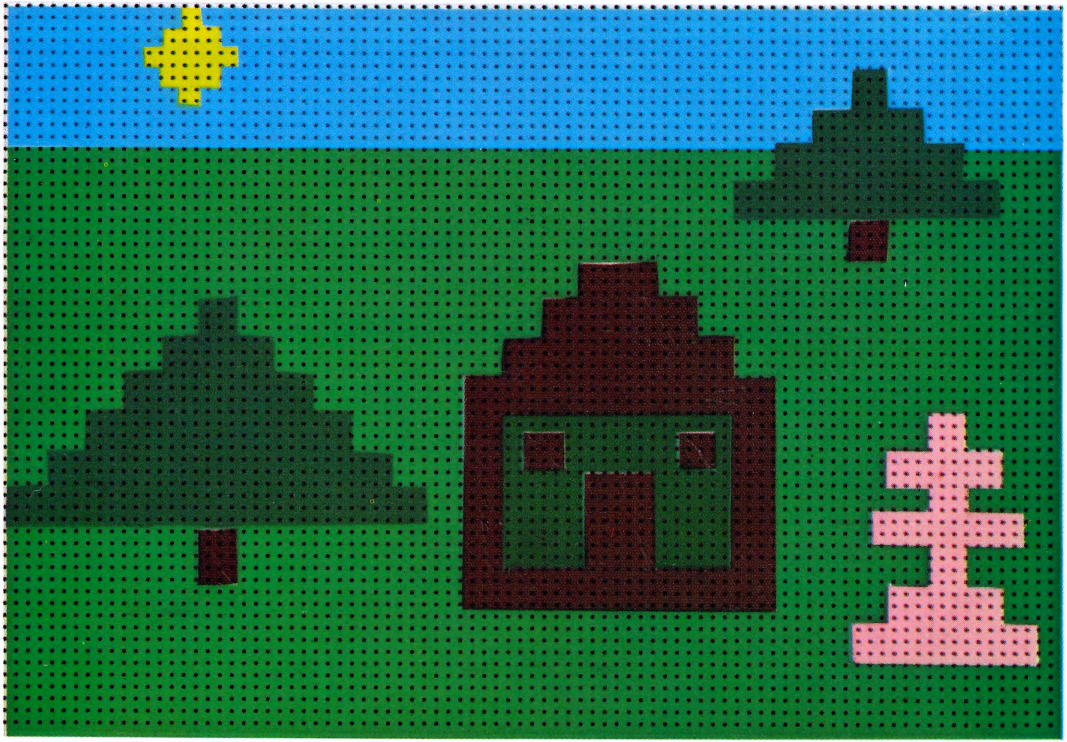




FLAG—*Page 53*



SAILBOAT—*Page 56*



PICTURE—*Page 57*

graphics features interact with the color in your monitor. Change Line 30 so the lines are plotted on odd values of X:

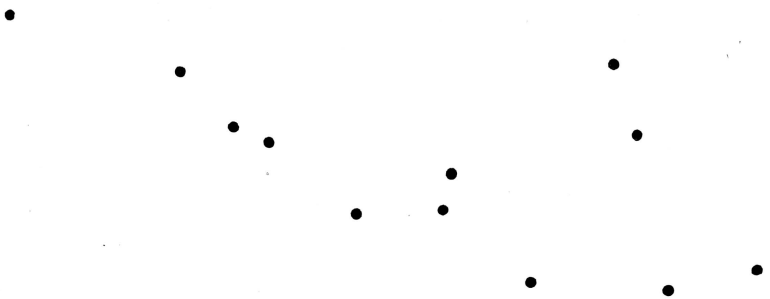
```
30 FOR X=21 TO 91 STEP 8
```

Change the colors and see which ones are visible now.

Green and Orange are visible on the odd lines, whereas, Blue and Violet are visible on the even lines. This factor will cause vertical lines to disappear and create gaps in horizontal lines. In addition, the colors of a figure plotted in white will change if the figure moves across the screen.

EXERCISE 3

Plot a series of points with HPLOT.



```
10  HGR
20  HCOLOR= 3
30  INPUT X,Y
40  HPLOT X,Y
50  GOTO 30
```

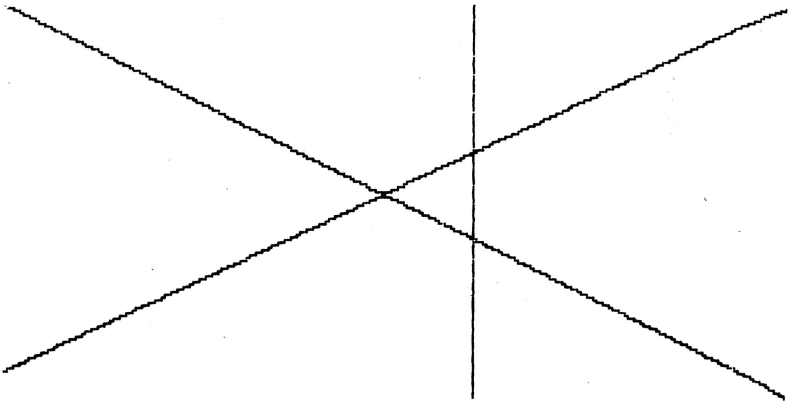
See what happens if you try to use a number larger than 7 in Line 20.

Experiment with different X,Y coordinates and see where the points are plotted. What happens if you input a value larger than the 279 for X or 159 for Y?

Notice that the bottom of the screen is used for text only, no points are plotted there.

EXERCISE 4

Now use the immediate mode to plot a series of lines using different colors and X,Y coordinates.

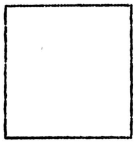


```
]HGR

]HCOLOR=3

]HPLOT 1,1 TO 250,150

]HPLOT 1,140 TO 250,1

]HPLOT 150,1 TO 150,150
```

Try using different X,Y coordinates and draw lines all over the screen.

EXERCISE 5

Use HPLOT to draw a box.

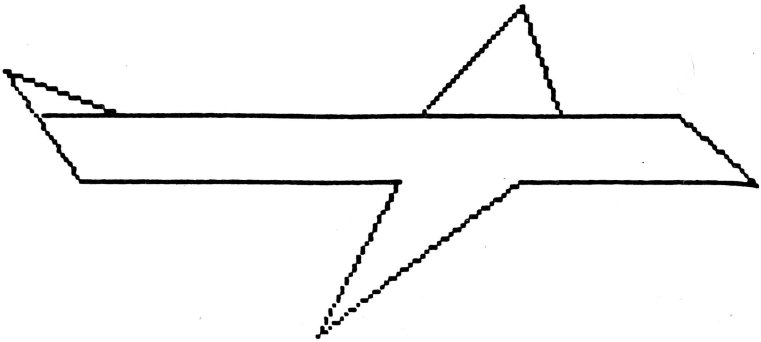


```
]HGR

]HCOLOR=3

]HPLOT 10,20 TO 50,20

]HPLOT TO 50,70

]HPLOT TO 10,70

]HPLOT TO 10,20
```

Try drawing different-sized boxes at other locations on the screen. Now use HPLOT and HCOLOR to make other figures and shapes.

JET PLANE

The computer can draw a jet airplane with this program. Can you improve upon the design?



PROGRAM LISTING

```
100   HGR : HCOLOR= 3
110   HPLOT 80,100 TO 240,100
120   HPLOT  TO 260,115
130   HPLOT  TO 200,115
140   HPLOT  TO 150,150
150   HPLOT  TO 170,115
160   HPLOT  TO 90,115
170   HPLOT  TO 70,90
180   HPLOT  TO 100,100
190   HPLOT 175,100 TO 200,75
200   HPLOT  TO 210,100
```

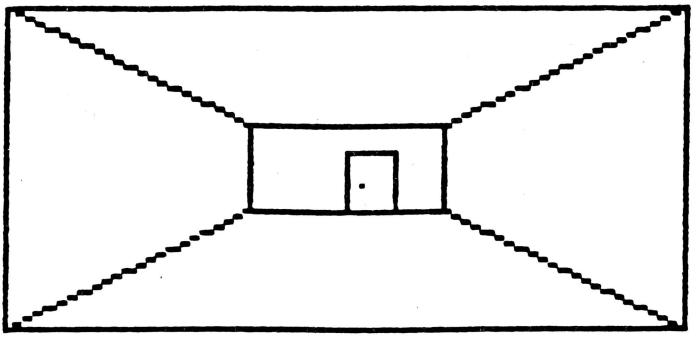
NOTE

Lines 120-170: Notice that these HPLOT statements all use the prior point as the starting point.

3-D ROOM

The computer draws a three-dimensional room with a door in the far wall.

Change the program so the far wall seems even farther away.



PROGRAM LISTING

```
100  HGR
110  HCOLOR= 3
120  HPLOT 10,30 TO 10,100 TO 140,
     100 TO 140,30 TO 10,30
130  HPLOT 50,50 TO 50,80 TO 100,
     80 TO 100,50 TO 50,50
140  HPLOT 10,30 TO 50,50
150  HPLOT 100,50 TO 140,30
160  HPLOT 100,80 TO 140,100
170  HPLOT 10,100 TO 50,80
180  HPLOT 75,80 TO 75,65 TO 85,6
     5 TO 85,80
190  HPLOT 78,72
```

NOTES

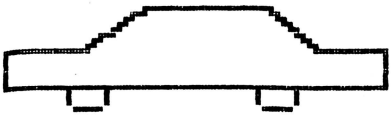
Lines 120, 130: Draw the rectangles using one HPLOT statement.

Lines 140-170: Connect the corners of the rectangles.

Line 180: Draws the door as one continuous shape.

CAR

Here is a car ready to drive across the screen in a later chapter. Try to design your favorite sports car or a racing model.



PROGRAM LISTING

```
100  HGR : HCOLOR= 3
110 X = 40:Y = 100
120  REM  BODY OF CAR
130  HPLOT X,Y TO X + 20,Y
140  HPLOT  TO X + 27,Y + 8 TO X +
     38,Y + 8 TO X + 38,Y + 15 TO
     X - 22,Y + 15 TO X - 22,Y +
     8 TO X - 10,Y + 8 TO X,Y
150  REM  TIRES
160  HPLOT X - 12,Y + 16 TO X - 1
     2,Y + 18
170  HPLOT X - 11,Y + 19 TO X - 7,
     Y + 19
180  HPLOT X - 6,Y + 18 TO X - 6,
     Y + 16
190  HPLOT X + 18,Y + 16 TO X + 1
     8,Y + 18
200  HPLOT X + 19,Y + 19 TO X + 2
     3,Y + 19
210  HPLOT X + 24,Y + 18 TO X + 2
     4,Y + 16
```

NOTES

Line 110: Sets the X,Y coordinates to start drawing the car. This allows the programmer to place a figure anywhere on the screen.

Line 130: Starts drawing the car using the X,Y coordinates set in Line 110.

FISH

Use HPLOT to make a fish.
Can you change the size of this fish and add others to the picture?

PROGRAM LISTING

```
100  HGR : HCOLOR= 3
110 X = 20:Y = 100
120  HPLOT X,Y TO X + 35,Y - 12
130  HPLOT  TO X + 45,Y
140  HPLOT  TO X + 34,Y + 8
150  HPLOT  TO X,Y - 8
160  HPLOT  TO X,Y
170  HPLOT X + 39,Y - 2
```

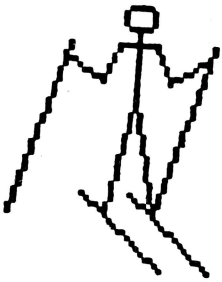
NOTES

Line 110: Gives the X,Y, coordinates for the first point to plot in drawing the fish. This allows you to move the fish to different locations on the screen just by changing X and Y.

Lines 130-160: Could also be put in one HPLOT statement.

SKIER

This skier will take off down the slopes in the last chapter. See if you can design a person on a sled to substitute for the skier.



PROGRAM LISTING

```
100  HGR : HCOLOR= 3
110 X = 100:Y = 50
120  REM  DRAW SKIER
130  REM    HEAD
140  HPLOT X,Y TO X + 3,Y + 1 TO
     X + 2,Y + 3 TO X,Y + 3 TO X -
     1,Y + 1 TO X,Y
150  REM  DRAW BODY
160  HPLOT X + 1,Y + 4 TO X + 1,Y
      + 15
170  REM    LEGS
180  HPLOT  TO X - 5,Y + 33
190  HPLOT X + 1,Y + 15 TO X + 7,
     Y + 32
200  REM     SKIS
210  HPLOT X - 12,Y + 28 TO X + 6,
     Y + 39
220  HPLOT X + 1,Y + 27 TO X + 17,
     Y + 38
230  REM  ARMS AND POLES
```

```
240  HPLOT X + 2,Y + 7 TO X + 5,Y
      + 10 TO X + 11,Y + 8 TO X +
     9,Y + 30
250  HPLOT X,Y + 7 TO X - 3,Y + 1
     0 TO X - 7,Y + 9 TO X - 14,Y
      + 34
```

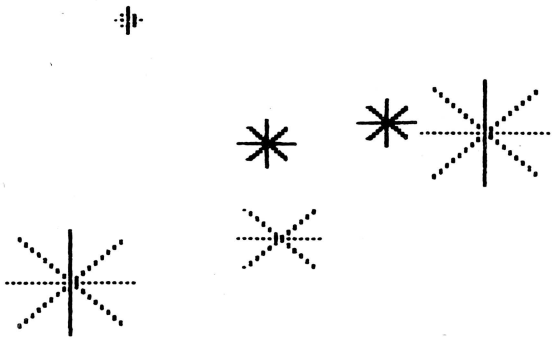
NOTE

Line 140: Draws the skier's head in one continuous shape.

SNOWFLAKES

Fill the screen with different-sized snowflakes.

Change the program to print out even more random snowflakes on your screen.



PROGRAM LISTING

```
100  HGR2
110  FOR N = 1 TO 7
120  HCOLOR= N
130 X =  INT ( RND (1) * 230 + 25
     )
140 Y =  INT ( RND (1) * 130 + 25
     )
150 L =  INT ( RND (1) * 20 + 5)
160  HPLOT X - L,Y TO X + L,Y
170  HPLOT X,Y - L TO X,Y + L
180 L = L - 3
190 SX = X - L:SY = Y - L
200  HPLOT SX,SY TO SX + 2 * L,SY
      + 2 * L
210 SY = Y + L
220  HPLOT SX,SY TO SX + 2 * L,SY
      - 2 * L
230  NEXT N
```

NOTES

Line 100: The HGR2 statement increases the size of the Hi-Res screen to 280 by 192. This gives more room for graphics and eliminates the text window. To change back to Text mode, type TEXT and hit return.

Line 110: Each snowflake is plotted in a different color, 1 to 7. Notice that there are only 6 snowflakes on your screen—since HCOLOR = 4 is Black, this snowflake is not visible.

Line 130: This line uses the RND(1) function to find a random number between 25 and 230 for the starting position on the X axis.

Line 140: This line uses the RND(1) function to find a random number between 25 and 130 for the starting position on the Y axis.

Line 150: This line uses the RND(1) function to find a random number between 5 and 20 for the size of the snowflake.

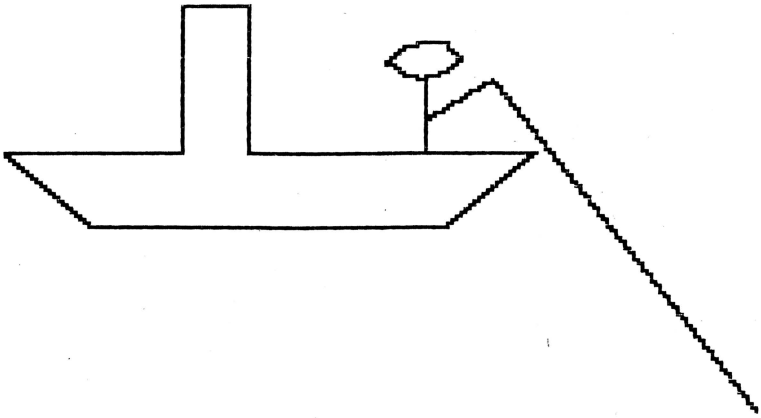
Line 160: Draws a horizontal line with length 2 times L.

Line 180: Subtracts 3 from L so the diagonal lines are shorter than the others.

FISHING BOAT

This fisherman is hoping a fish will come along.

See if you can change the program to make his boat look like a cabin cruiser, or add some fish to the picture.



PROGRAM LISTING

```
100  HGR : HCOLOR= 3
110  HPLOT 40,50 TO 80,50 TO 80,1
     0 TO 95,10 TO 95,50 TO 160,5
     0 TO 140,70 TO 60,70 TO 40,5
     0
120  HPLOT 135,50 TO 135,30 TO 13
     0,28 TO 126,25 TO 130,21 TO
     133,20 TO 140,21 TO 143,25 TO
     140,28 TO 135,30
130  HPLOT 135,41 TO 150,30 TO 21
     0,120
```

NOTES

Line 110: Draws the boat as a continuous shape.

Line 120: Draws the head and body of the fisherman.

Line 130: Draws the arm and fishing line.

5 ANIMATION

Now try moving objects around on the screen.

PROGRAMS

1. Warm-ups
2. Race Car
3. The Jogger
4. Flying Bird
5. Jumping Fish
6. Walking Girl
7. Helicopter

WARM-UPS

Moving a shape across the screen requires 3 steps:

1. Draw the shape.
2. Erase the shape.
3. Draw it in a new location.

The faster the computer can do steps 1, 2, and 3, the faster the shape will move. If there is a delay between steps 2 and 3, the shape will flicker as it moves.

Any of the graphics statements can be used to draw the shape. Then, to erase it, use the same statements, but set color to 0—the background color.

EXERCISE 1

Use the PLOT statement to draw a block of color and then move it across the screen.

```
10  GR
20  FOR X = 1 TO 35
30  COLOR= 1: PLOT X,30
35  FOR I = 1 TO 50: NEXT I
40  COLOR= 0: PLOT X,30
50  NEXT X
```

Take out the Wait Loop in Line 35 and see how fast the block moves across the screen.

Change the program to move the block *up* the screen:

```
20  FOR Y = 39 TO 1 STEP - 1
30  COLOR= 1: PLOT 30,Y
```

```
40   COLOR= 0: PLOT 30,Y
50   NEXT Y
```

EXERCISE 2

Now draw a rocket in Hi-Res mode and make it blast off the screen.

```
100  HGR :X = 100
110  FOR Y = 150 TO 40 STEP  - 10

120  HCOLOR= 3: GOSUB 300
130  HCOLOR= 0: GOSUB 300
140  NEXT Y
150  END
300  REM  DRAW ROCKET
310  HPLOT X,Y TO X,Y - 30 TO X +
     3,Y - 35 TO X + 6,Y - 30 TO
     X + 6,Y TO X + 3,Y - 5 TO X,
     Y
320  RETURN
```

Line 120 sets HCOLOR to 3 and then calls the subroutine that draws the rocket. Line 130 erases the rocket by setting HCOLOR to 0, or black, before calling the same subroutine.

Repeating these steps moves the rocket up the screen.

Add a Wait Loop between Lines 120 and 130 and see if you like the results.

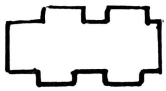
EXERCISE 3

This exercise moves the car from Chapter 4 across the screen.

```
100  HGR :Y = 100
110  FOR X = 230 TO 25 STEP  - 15

120  HCOLOR= 3: GOSUB 300
130  HCOLOR= 0: GOSUB 300
140  NEXT X
150  END
295  REM  DRAW CAR
300  HPLOT X,Y TO X + 20,Y
310  HPLOT  TO X + 27,Y + 8 TO X +
     38,Y + 8 TO X + 38,Y + 15 TO
     X - 22,Y + 15 TO X - 22,Y +
     8 TO X - 10,Y + 8 TO X,Y
320  HPLOT X - 12,Y + 16 TO X - 1
     2,Y + 18
330  HPLOT X - 11,Y + 19 TO X - 7,
     Y + 19
340  HPLOT X - 6,Y + 18 TO X - 6,
     Y + 16
350  HPLOT X + 18,Y + 16 TO X + 1
     8,Y + 18
360  HPLOT X + 19,Y + 19 TO X + 2
     3,Y + 19
370  HPLOT X + 24,Y + 18 TO X + 2
     4,Y + 16
380  RETURN
```

RACE CAR

Use Low-Resolution graphics to draw a race car and move it across the screen.



PROGRAM LISTING

```
100  GR : HOME
110 Y = 15
120  FOR X = 1 TO 30 STEP 2
130  COLOR= 2: GOSUB 180
140  FOR I = 1 TO 50: NEXT I
150  COLOR= 0: GOSUB 180
160  NEXT X
170  END
180  REM  DRAW CAR
190  HLIN X,X + 4 AT Y
200  HLIN X,X + 4 AT Y + 1
210  PLOT X + 1,Y - 1: PLOT X + 3,
     Y - 1
220  PLOT X + 1,Y + 2: PLOT X + 3,
     Y + 2
230  RETURN
```

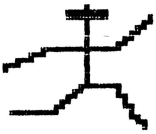
NOTE

Line 140: This Wait Loop keeps the car on the screen longer and reduces the flicker. Try running the program without this line and see what happens.

THE JOGGER

Now use High-Resolution graphics to make a runner race across the screen.

Change the positions of the runner's arms and legs to make the figure look more realistic.



PROGRAM LISTING

```
100  HGR
110 Y = 50
120  FOR X = 15 TO 250 STEP 10
130  HCOLOR= 3: GOSUB 200
140  HCOLOR= 0: GOSUB 200
150  HCOLOR= 3: GOSUB 290
160  HCOLOR= 0: GOSUB 290
170  NEXT X
180  END
190  REM  FIRST POSITION
200  HPLOT X,Y TO X,Y + 15
210  HPLOT X - 3,Y + 1 TO X + 3,Y
      + 1
220  HPLOT X - 3,Y + 2 TO X + 3,Y
      + 2
230  HPLOT X,Y + 8 TO X - 5,Y + 8
      TO X - 13,Y + 2
240  HPLOT X,Y + 8 TO X + 5,Y + 8
      TO X + 13,Y + 2
250  HPLOT X,Y + 15 TO X - 7,Y +
     22
260  HPLOT X,Y + 15 TO X + 7,Y +
     22
```

```
270  RETURN
280  REM  SECOND POSITION
290  HPLOT X,Y TO X,Y + 15
300  HPLOT X - 3,Y + 1 TO X + 3,Y
      + 1
310  HPLOT X - 3,Y + 2 TO X + 3,Y
      + 2
320  HPLOT X,Y + 8 TO X - 5,Y + 8
      TO X - 13,Y + 12
330  HPLOT X,Y + 8 TO X + 5,Y + 8
      TO X + 10,Y + 2
340  HPLOT X,Y + 15 TO X - 5,Y +
     20 TO X - 12,Y + 20
350  HPLOT X,Y + 15 TO X + 5,Y +
     16 TO X + 9,Y + 23
360  RETURN
```

NOTES

Lines 130, 140: Draw and erase the figure in the first running position.

Lines 150, 160: Draw and erase the figure in the second running position.

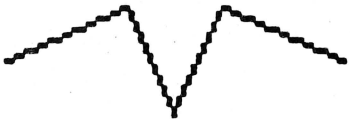
Lines 200-260: This subroutine draws the figure in the first running position.

Lines 290-350: This subroutine draws the figure in the second running position.

FLYING BIRD

Make a bird fly across the screen. This program uses three positions of the bird's wings in order to simulate motion.

Try making a bird or a butterfly of your own.



PROGRAM LISTING

```
100  HGR : HCOLOR= 3
110  FOR X = 1 TO 175 STEP 5
120 Y = X / 2
130  HGR : HCOLOR= 3
140  HPLOT X + 15,Y + 40 TO X + 4
     0,Y + 30
150  HPLOT  TO X + 50,Y + 50
160  HPLOT  TO X + 60,Y + 30
170  HPLOT  TO X + 85,Y + 40
180  HGR : HCOLOR= 3
190  HPLOT X + 10,Y + 35 TO X + 4
     0,Y + 35
200  HPLOT  TO X + 50,Y + 50
210  HPLOT  TO X + 60,Y + 35
220  HPLOT  TO X + 85,Y + 35
230  HGR : HCOLOR= 3
240  HPLOT X + 10,Y + 30 TO X + 5
     0,Y + 50
250  HPLOT  TO X + 85,Y + 30
260  NEXT X
```

NOTES

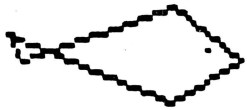
Line 120: Sets the Y coordinate of the bird's position to X/2. This makes the bird fly on a diagonal down the screen.

Lines 130, 180, 230: Erase the bird, using the HGR command. Since there are no other images on the screen, this is an easy way to erase an image.

JUMPING FISH

This fish swims across the screen and also jumps out of the water until you hit Control-C.

Change the speed he swims by changing the step increments on Lines 130 and 250.



PROGRAM LISTING

```
100  HGR : HCOLOR= 6
110  HPLOT 1,70 TO 270,70
120 Y = 100
130  FOR X = 2 TO 100 STEP 10
140  HCOLOR= 3: GOSUB 300
150  HCOLOR= 0: GOSUB 300
160  NEXT X
170  FOR Y = 100 TO 20 STEP  - 5
180  HCOLOR= 3: GOSUB 300
190  HCOLOR= 0: GOSUB 300
200  NEXT Y
210  FOR Y = 20 TO 100 STEP 5
220  HCOLOR= 3: GOSUB 300
230  HCOLOR= 0: GOSUB 300
240  NEXT Y
250  FOR X = 110 TO 230 STEP 10
260  HCOLOR= 3: GOSUB 300
```

```
270  HCOLOR= 0: GOSUB 300
280  NEXT X
290  GOTO 100
300  HPLOT X,Y TO X + 35,Y - 12
310  HPLOT  TO X + 45,Y
320  HPLOT  TO X + 34,Y + 8
330  HPLOT  TO X,Y - 8
340  HPLOT  TO X,Y
350  HPLOT X + 38,Y - 2
360  RETURN
```

NOTES

Line 110: Draws a blue line across the screen for the water.

Lines 130-160: Move the fish across the screen.

Lines 170-200: Make the fish jump up.

Lines 210-240: Make the fish jump down.

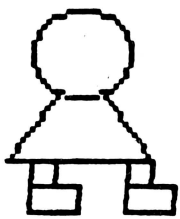
Lines 250-280: Move the fish the rest of the way across the screen.

WALKING GIRL

Make a simple cartoon character walk across the screen.

To make your own figure, just draw your character in two or more walking positions and then alternate the positions as you move your figure across the screen.

Try making an animal walk or run across the screen.



PROGRAM LISTING

```
100  HGR
110 Y = 100
120  FOR X = 20 TO 220 STEP 10
130  HCOLOR= 3: GOSUB 300
140  HCOLOR= 0: GOSUB 300
150  HCOLOR= 3: GOSUB 400
160  HCOLOR= 0: GOSUB 400
170  NEXT X
180  GOTO 120
290  REM  WALKING POSITION 1
300  HPLOT X,Y TO X + 8,Y TO X +
     12,Y + 6 TO X + 8,Y + 10 TO
     X,Y + 10 TO X - 4,Y + 6 TO X,
     Y
310  HPLOT X,Y + 10 TO X - 10,Y +
     20
320  HPLOT  TO X + 20,Y + 20
330  HPLOT  TO X + 12,Y + 10
```

```
340  HPLOT X - 8,Y + 20 TO X - 8,
     Y + 30 TO X,Y + 30 TO X,Y +
     26 TO X - 4,Y + 26 TO X - 5,
     Y + 20
350  HPLOT X + 15,Y + 20 TO X + 1
     5,Y + 30 TO X + 23,Y + 30 TO
     X + 23,Y + 26 TO X + 19,Y +
     26 TO X + 18,Y + 20
360  RETURN
390  REM  WALKING POSITION 2
400  HPLOT X,Y TO X + 8,Y TO X +
     12,Y + 6 TO X + 8,Y + 10 TO
     X,Y + 10 TO X - 4,Y + 6 TO X,
     Y
410  HPLOT X,Y + 10 TO X - 10,Y +
     20
420  HPLOT  TO X + 20,Y + 20
430  HPLOT  TO X + 12,Y + 10
440  HPLOT X,Y + 20 TO X,Y + 30 TO
     X + 12,Y + 30 TO X + 12,Y +
     26 TO X + 8,Y + 26 TO X + 8,
     Y + 20
450  RETURN
```

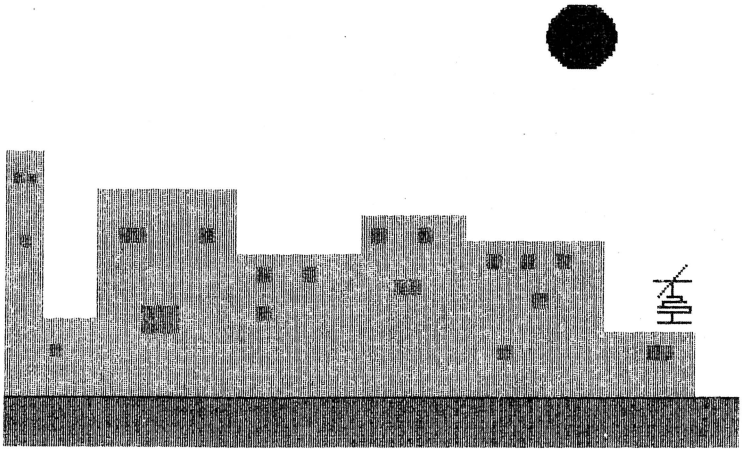
NOTE

Lines 130, 140: The drawings of the figure are placed in subroutines starting on Lines 300 and 400. This helps the programmer separate the action part of the program from the initial drawings.

HELICOPTER

Watch your computer draw a helicopter fly above a city skyline and land on the top of a building.

Once this program is running, try adding a sun and some windows.



PROGRAM LISTING

```
100  HGR2
110  HCOLOR= 5
120  GOSUB 350
130 Y = 10
140  FOR X = 10 TO 200 STEP 15
150  HCOLOR= 3: GOSUB 250
160  FOR I = 1 TO 50: NEXT I
170  HCOLOR= 0: GOSUB 250
180  NEXT X
190 X = 200
200  FOR Y = 10 TO 80 STEP 10
210  HCOLOR= 3: GOSUB 250
220  HCOLOR= 0: GOSUB 250
```

```
230  NEXT Y
240  HCOLOR= 3: GOSUB 250: END
250  REM  DRAW HELICOPTER
260  HPLOT X,Y TO X + 20,Y
270  HPLOT X + 4,Y + 4 TO X + 16,
     Y - 4
280  HPLOT X + 10,Y TO X + 10,Y +
     8
290  HPLOT X + 8,Y + 8 TO X + 12,
     Y + 8 TO X + 12,Y + 12
300  HPLOT X + 14,Y + 12 TO X + 6,
     Y + 12 TO X + 6,Y + 14
310  HPLOT X + 2,Y + 14 TO X + 18,
     Y + 14 TO X + 18,Y + 16 TO
     X + 2,Y + 16
320  HPLOT X + 10,Y + 16 TO X + 1
     0,Y + 20
330  HPLOT X + 2,Y + 20 TO X + 18,
     Y + 20
340  RETURN
350  REM  DRAW SKYLINE
360  HPLOT 1,180 TO 1,45 TO 17,45
      TO 17,110 TO 41,110 TO 41,6
     0 TO 81,60 TO 81,90 TO 121,9
     0 TO 121,75
370  HPLOT  TO 141,75 TO 141,80 TO
     191,80 TO 191,110 TO 221,110
      TO 221,130 TO 231,130 TO 23
     1,180
380  RETURN
```

NOTES

Line 100: Since this program uses the HGR2 statement, you will not see the text cursor when the program ends. Type TEXT to return to Text mode once the helicopter lands.

Lines 140-180: Move the helicopter across the screen.

Lines 200-230: Move the helicopter down the screen to the landing pad.

Line 240: Draws the helicopter after it lands since the last statement in the FOR . . . NEXT loop erases it.

Lines 260-340: Draw the helicopter.

Lines 360-390: Draw the skyline.

6 FUN WITH GEOMETRY

You can use the built-in functions SIN and COS to draw many geometric shapes, such as a square, triangle, or circle. You can even make flowers and fancy designs.

PROGRAMS

1. Warm-ups
2. Apple Tree Harvest
3. Leaping Fish
4. Bird and Flower
5. Fancy Graphics
6. Ski Game

WARM-UPS

EXERCISE 1

Use the SIN function to draw a wave across the top of your screen.

```
100  HGR : HCOLOR= 2
110 H = 10:D = 30:A = 0:B = 20:C =
     .3
120  HPLOT A,D
130  FOR X = A TO B STEP C
140 Y =  SIN (X) * H + D
150  HPLOT  TO X * H,Y
160  NEXT X
```

The numeric variables on Line 110 are used as follows:

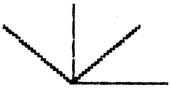
H: height of wave
D: location on Y axis
A: beginning point on X axis
B: last point on X axis
C: size of step along X axis

Experiment with different values for these variables and see how the wave changes.

Replace the SIN function with the COS function on Line 140 and see how the wave changes.

EXERCISE 2

We can use the SIN and COS functions to draw any angle we want. This example draws 0 degrees, 45 degrees, 90 degrees, and 135 degrees.



```
100  HGR :R = 30
110  INPUT A
120  HCOLOR= 3
130 AR = A * (3.14159 / 180)
140 X1 = R *  COS (AR) + 100
150 Y1 =  - R *  SIN (AR) + 100
160  HPLOT 100,100 TO X1,Y1
170  GOTO 110
```

Experiment with different values of R and A and see what angles you make.

Line 130 converts the angle A from degrees to radians using the equation:

Radians = degrees * (PI/180) [for PI = 3.14159]

Lines 140 and 150 determine the ending X,Y coordinates for the line and add these values to the point (100,100). This translates the (0,0) point from the top left point on the screen to (100,100).

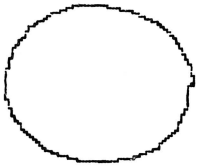
Line 150 uses a negative R because the Y coordinate on your screen is the reverse of the Y coordinate on a normal X,Y axis. The Y coordinate on your screen increases as you move down rather than up. Therefore, you must change the sign of Y in order to make it the same as a normal X,Y axis.

EXERCISE 3

Draw a circle, using the SIN and COS functions. These equations:

X = R * COS (I) + XC
Y = R * SIN (I) + YC

give the X,Y coordinates for any point on the circumference of a circle with a radius of R and center at XC,YC.



```
100  HGR : HCOLOR= 3
110 XC = 100:YC = 75:R = 30:S = 0
     :E = 6.6:J = .3
120  HPLOT XC + R,YC
130  FOR I = S TO E STEP J
140 X = R *  COS (I) + XC
150 Y =  - R *  SIN (I) + YC
160  HPLOT  TO X,Y
170  NEXT I
```

The numeric variables on Line 110 are used as follows:

XC: center of circle X-axis
YC: center of circle Y-axis
R: radius of circle
S: radians to begin drawing
E: radians to end drawing
J: increment to step while drawing

S and E determine which part of the circle is drawn. To make a complete circle, set S = O and E = 6.6. To draw a part of the circle, change S or E to any number between 0 and 6.6. Experiment with different combinations for S and E and see which part of the circle you make. Just be sure to make E larger than S.

Change the value of J and see how it affects your circle.

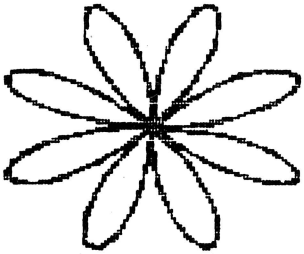
To make an ellipse, make R different for X than Y.

```
150 Y=-1.5*R*COS(I)+YC
```

Vary the shape of the ellipse by changing the radius R for X and Y.

EXERCISE 4

Draw a flower, using the SIN and COS functions.



```
100  HGR : HCOLOR= 3
110 N = 4:A = 50:PI = 3.14159
120 M = N * PI * 2
130  HPLOT 100,100
140  FOR I = 0 TO M STEP .1
150 R = A *  SIN (N * I)
160 X = R *  COS (I) + 100
170 Y =  - R *  SIN (I) + 100
180  HPLOT  TO X,Y
190  NEXT I
```

The numeric variables on Line 110 are used as follows:

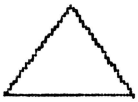
A: size of the flower
N: number of petals drawn
  If N is even, flower has 2 * N petals
  If N is odd, flower has N petals

Change the value of N and see what your flower looks like. Try using a decimal number for N and see what you get.

Line 150 uses an equation called "N-leaved rose" to find a value for R. Notice that R changes each time the FOR . . . NEXT loop executes.

EXERCISE 5

We can use these equations to draw geometric shapes also. To make a triangle, we need to draw 3 sides, turning 120 degrees each time.



```
100  HGR : HCOLOR= 3
110 A = 120 * (3.14159 / 180)
120 R = 40:AR = A
130 X2 = R *  COS (AR) + 100
140 Y2 =  - R *  SIN (AR) + 100
150  HPLOT 100,100 TO X2,Y2
160 AR = AR + A:X1 = X2:Y1 = Y2:
170 X2 = R *  COS (AR) + X1
180 Y2 =  - R *  SIN (AR) + Y1
190  HPLOT X1,Y1 TO X2,Y2
200  HPLOT X2,Y2 TO 100,100
```

The numeric variables are used as follows:

A: angle in degrees
AR: angle in radians
R: length of side
X1, Y1: X,Y coordinates for start of line
X2, Y2: X,Y coordinates for end of line

Lines 130-140 and 170-180 add the new values of X,Y to the starting coordinates X1,Y1. This moves the origin each time to the starting point of the line.

EXERCISE 6

To draw a square, draw 4 sides and turn 90 degrees each time.

```
100  HGR : HCOLOR= 3
110 A = 360 / 4
120 AR = A * (3.14159 / 180)
130 X1 = 150:Y1 = 150:R = 20
140  HPLOT X1,Y1
150  FOR I = 0 TO 3
160 X2 = R *  COS (AR * I) + X1
170 Y2 =  - R *  SIN (AR * I) + Y
     1
180  HPLOT  TO X2,Y2
190 X1 = X2:Y1 = Y2:
200  NEXT I
```

This program is a more efficient version of Exercise 5. The sides are drawn inside the FOR . . . NEXT loop, Lines 150-200.

EXERCISE 7

Now you can draw a N-sided shape just by changing some of the lines in Exercise 6 as follows:

```
105 INPUT N
110 A=360/N

150 FOR I=0 TO N-1
```

Try different values of N and see what shapes you make. How large must N be before your shape looks like a circle?

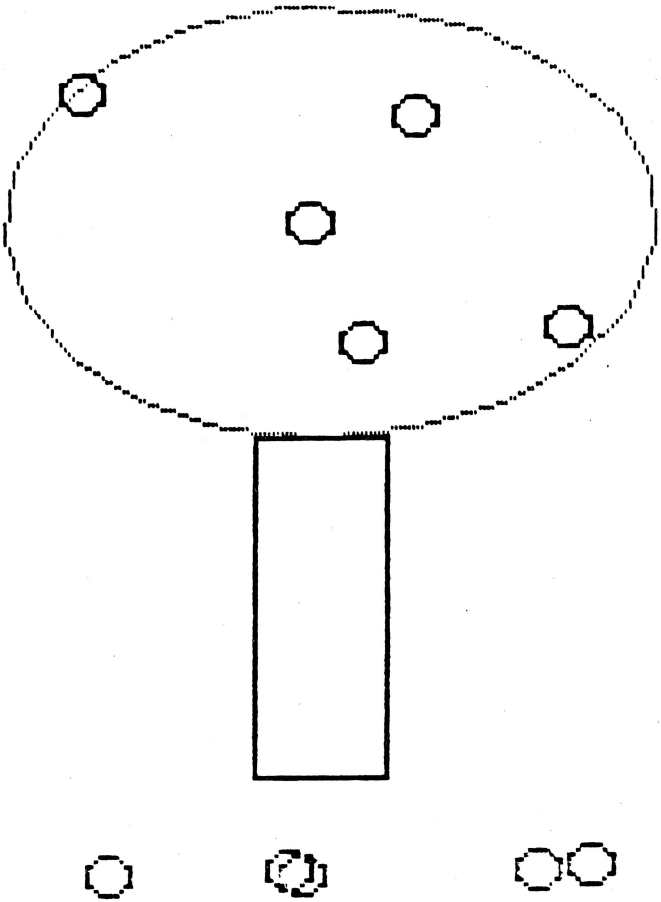
Now try using these ideas in some programs.

APPLE TREE HARVEST

Use the equations for an ellipse to draw an apple tree. This tree starts out with 10 apples, but some fall off.

Create your own picture by adding other figures to this one.

Change Line 250 to put more apples on the tree. Can you make them all fall off?



PROGRAM LISTING

```
100  HGR
110  DIM X(10),Y(10)
120 RX = 75:RY = 45:XC = 152:YC =
     55
130  REM  DRAW TREE
140  HCOLOR= 1
150  HPLOT XC,RY + YC
160  FOR I =  - 1.6 TO 4.9 STEP .
     3
170 X = RX *  COS (I) + XC
180 Y =  - RY *  SIN (I) + YC
190  HPLOT  TO X,Y
200  NEXT I
210  HCOLOR= 2
220  REM  DRAW TRUNK
230  HPLOT X - 15,Y TO X - 15,Y +
     60 TO X + 15,Y + 60 TO X + 1
     5,Y
240  HCOLOR= 7:XX = 7:YY = 5
250  FOR C = 1 TO 10
260 A =  INT ( RND (1) * 95 + 105)
270 B =  INT ( RND (1) * 65 + 20)

280  GOSUB 420
290 XA(C) = A:YA(C) = B
300  NEXT C
310  REM  MAKE APPLES FALL
320  FOR C = 10 TO 1 STEP  - 2
330 A = XA(C)
340  FOR B = YA(C) TO 150 STEP 5
350  HCOLOR= 7: GOSUB 420
360  HCOLOR= 0: GOSUB 420
370  NEXT B
```

```
380  HCOLOR= 7: GOSUB 420
390  NEXT C
400  END
410  REM  DRAW APPLES
420  HPLOT A - 5,B TO A + 5,B
430  HPLOT A - 4,B + 1 TO A + 4,B
       + 1
440  HPLOT A - 3,B + 2 TO A + 3,B
       + 2
450  HPLOT A - 2,B + 3 TO A + 2,B
       + 3
460  HPLOT A - 4,B - 1 TO A + 4,B
       - 1
470  HPLOT A - 3,B - 2 TO A + 3,B
       - 2
480  HPLOT A - 2,B - 3 TO A + 2,B
       - 3
490  RETURN
```

NOTES

Line 110: The DIM (dimension) statement sets aside space for the arrays X and Y.

Lines 140-200: Draw an ellipse for the tree.

Lines 250-300: Put apples on the tree and save the X,Y coordinates for each apple in arrays XA and YA. Line 260 finds a random X location for the apple within the circumference of the ellipse. Line 270 finds a random Y location.

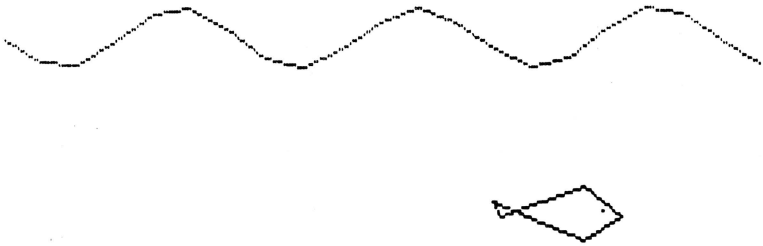
Lines 320-390: Move every other apple to the bottom of the screen.

Lines 420-490: Draw an apple, using a group of lines.

LEAPING FISH

Make our fish program from Chapter 5 more realistic by changing the line to a wave and making the fish jump in an arc instead of straight up.

Add some other fish or sea life and create your own underwater picture.



PROGRAM LISTING

```
100  HGR : HCOLOR= 6
110  GOSUB 420
120 Y = 80:YC = 80:R = 50
130  REM  MOVE FISH
140  FOR X = 0 TO 50 STEP 10
150  HCOLOR= 3: GOSUB 340
160  HCOLOR= 0: GOSUB 340
170  NEXT X
180  REM  MAKE FISH JUMP
190 XC = 100
200  FOR I = 3 TO 0 STEP  - .3
210 X = R *  COS (I) + XC
220 Y =  - R *  SIN (I) + YC
230  HCOLOR= 3: GOSUB 340
240  HCOLOR= 0: GOSUB 340
250  NEXT I
260  REM  MOVE FISH
270  FOR X = 150 TO 230 STEP 10
```

```
280  HCOLOR= 3: GOSUB 340
290  HCOLOR= 0: GOSUB 340
300  NEXT X
310  HCOLOR= 6
320  GOTO 110
330  REM  DRAW FISH
340  HPLOT X,Y TO X + 35,Y - 12
350  HPLOT  TO X + 45,Y
360  HPLOT  TO X + 34,Y + 8
370  HPLOT  TO X,Y - 8
380  HPLOT  TO X,Y
390  HPLOT X + 38,Y - 2
400  RETURN
410  REM  DRAW WAVE
420  HPLOT 0,50
430  FOR X = 0 TO 19 STEP 1
440 Y =  SIN (X) * 10 + 50
450  HPLOT  TO X * 14,Y
460  NEXT X
470  RETURN
```

NOTES

Lines 140-170: Move the fish.

Lines 200-250: Use the equations for a circle to make the fish jump in an arc.

Lines 270-300: Move the fish the rest of the way across the screen.

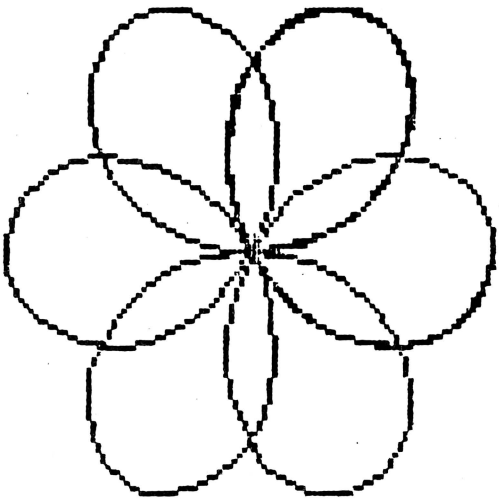
Lines 340-390: Draw the fish.

Lines 420-460: Use the SIN function to draw a wave across the top of the screen.

BIRD AND FLOWER

Make the bird from Chapter 5 fly to a flower.

Change the value of N on Line 130 and see how the flower changes.



PROGRAM LISTING

```
100  HGR2
110 X = 149:Y = 145:PI = 3.14159
120 N = 1.5
130  HCOLOR= 3: HPLOT X,Y
140  FOR I = 0 TO 5 * PI STEP .3
150 R = 50 *  SIN (N * I)
```

```
160 C = R *  COS (I) + X
170 D =  - R *  SIN (I) + Y
180  HPLOT  TO C,D
190  NEXT I
200  REM  PLOT BIRD
210  HPLOT 1,20
220  FOR X = 1 TO 90 STEP 4
230 Y = (6 / 15) * X + 20
240  HCOLOR= 2: GOSUB 330
250  HCOLOR= 0: GOSUB 330
260  HCOLOR= 2: GOSUB 390
270  HCOLOR= 0: GOSUB 390
280  HCOLOR= 2: GOSUB 450
290  HCOLOR= 0: GOSUB 450
300  NEXT X
310  HCOLOR= 2: GOSUB 330
320  END
330  REM  PLOT BIRD POSITION 1
340  HPLOT X + 15,Y + 40 TO X + 4
     0,Y + 30
350  HPLOT  TO X + 50,Y + 50
360  HPLOT  TO X + 60,Y + 30
370  HPLOT  TO X + 85,Y + 40
380  RETURN
390  REM  PLOT BIRD POSITION 2
400  HPLOT X + 10,Y + 35 TO X + 4
     0,Y + 35
410  HPLOT  TO X + 50,Y + 50
420  HPLOT  TO X + 60,Y + 35
430  HPLOT  TO X + 85,Y + 35
440  RETURN
450  REM  PLOT BIRD POSITION 3
460  HPLOT X + 10,Y + 30 TO X + 5
     0,Y + 50
470  HPLOT  TO X + 85,Y + 30
480  RETURN
```

NOTES

Lines 130-190: Draw the flower, using the "N-leaved rose" routine in Exercise 4.

Lines 220-300: Move the bird in a straight line from the point (1,20) to the top of the flower. Line 230 calculates the Y coordinate, using the equation of a straight line as follows:

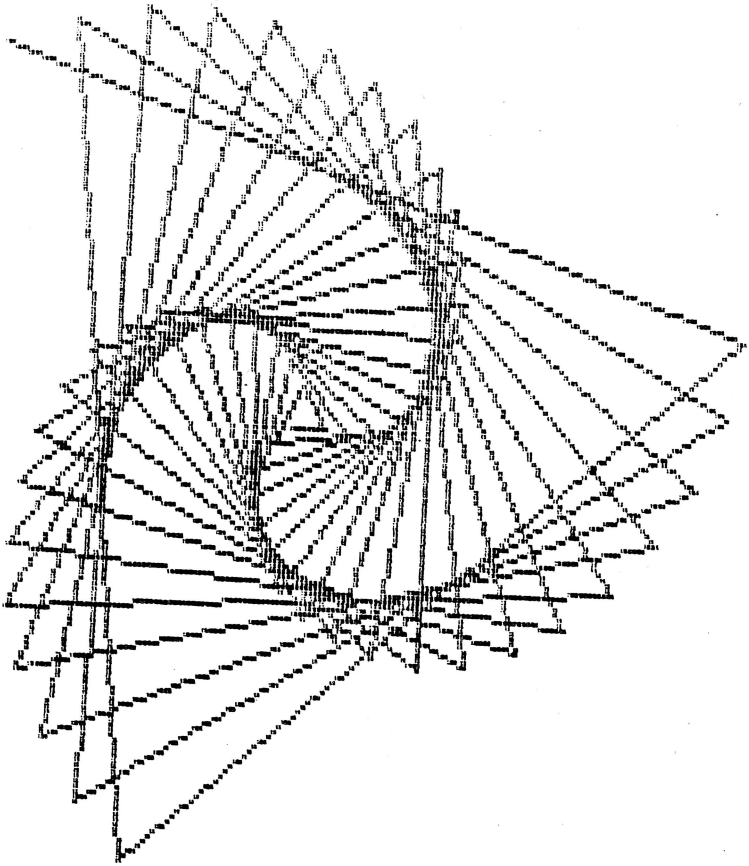
$Y = M * X + B$ where M = slope of line, and
B = Y intercept. (In this case, $M = 6/15$ and $B = 20$.)

Lines 330-480: Contain the subroutines used to draw each of the flying positions of the bird.

FANCY GRAPHICS

Make your own spirals and fancy designs.

Input different angles, in degrees, and see what fancy designs you can make. This example uses 123.



PROGRAM LISTING

```
100  HGR
110 R = 7:D = 3:C = 3
120  INPUT "ANGLE-IN DEGREES ":A
125  HGR
130 N = 360 / A: HCOLOR= C
140 A = A * (3.14159 / 180)
160 X1 = 100:Y1 = 70
165  HPLOT X1,Y1
170 I = 0
180 X2 = R *  COS (A * I) + X1
190 Y2 =  - R *  SIN (A * I) + Y1

200  IF X2 < 0 OR X2 > 290 THEN 1
     10
210  IF Y2 < 0 OR Y2 > 150 THEN 1
     10
220  HPLOT  TO X2,Y2
230 X1 = X2:Y1 = Y2
240 R = R + D
250 I = I + 1
260  GOTO 180
```

NOTES

Line 140: Converts angle A to radians.

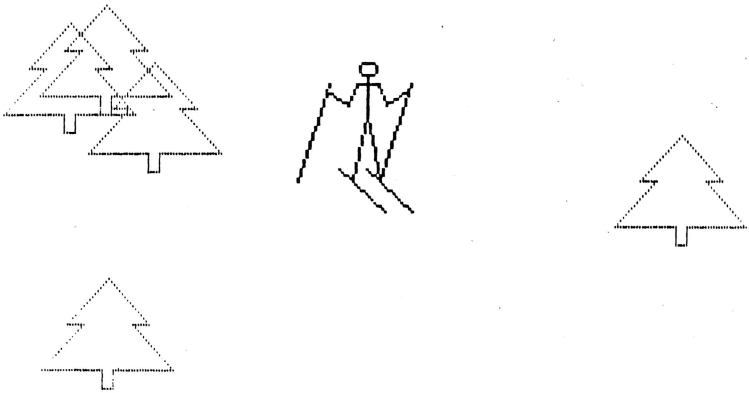
Lines 180, 190: Determine next X,Y coordinates.

Lines 200, 210: Stop the program when the design reaches the limits of the screen.

Line 240: Increments the length of side by D.

SKI GAME

A skier is moving down the slope between the trees. See if you can guide him safely through the forest. The L key makes him go right, the A key makes him go left, and the Space Bar moves him down the slope. If the skier crashes into a tree, the program stops. Good luck.



PROGRAM LISTING

```
100  DIM XT(5),YT(5)
110 XI = 20:YI = 35:SX = 100:P =
     10:SY = 20:IC = 25
120  HGR2
130  HCOLOR= 1: GOSUB 560
140 X = 100:Y = 20: HCOLOR= 3: GOSUB
     440
150 PX = 100:PY = 20
160  GOSUB 210
170  IF SY > 155 THEN  GOTO 110
180  GOSUB 260
190  GOTO 160
200  REM  KEYBOARD INPUT ROUTINE
210  GET A$
```

```
220  IF A$ =  CHR$ (65) THEN SX =
     SX - P
230  IF A$ =  CHR$ (76) THEN SX =
     SX + P
240  IF A$ =  CHR$ (32) THEN SY =
     SY + 6
250  RETURN
260  REM  MOVE SKIER RIGHT OR LEFT
270  IF SX > 10 AND SX < 220 THEN
     310
280 X = PX:Y = PY: HCOLOR= 0: GOSUB
     440
290  IF SX < 10 THEN SX = 220
300  IF SX > 220 THEN SX = 10
310 X = PX:Y = PY: HCOLOR= 0: GOSUB
     440
320 X = SX:Y = SY: HCOLOR= 3: GOSUB
     440
330 PX = SX:PY = SY
340  FOR I = 1 TO 5
350  IF YT(I) > SY + IC OR YT(I) +
     YI < SY THEN 380
360  IF SX + IC < XT(I) OR SX > X
     T(I) + XI THEN 380
370  GOTO 410
380  NEXT I
390  RETURN
400  REM  SKIER CRASHED
410  HPLOT SX - 13,SY + 10 TO SX +
     8,SY + 10
420  HPLOT SX - 3,SY TO SX - 3,SY
      + 20
430  END
440  REM  DRAW SKIER
450  HPLOT X,Y TO X + 3,Y + 1 TO
     X + 2,Y + 3 TO X,Y + 3 TO X -
     1,Y + 1 TO X,Y
```

```
460  HPLOT X + 1,Y + 4 TO X + 1,Y
      + 15
470  HPLOT  TO X - 5,Y + 33
480  HPLOT X + 1,Y + 15 TO X + 7,
     Y + 32
490  HPLOT X - 12,Y + 28 TO X + 6,
     Y + 39
500  HPLOT X + 1,Y + 27 TO X + 17,
     Y + 38
510  HPLOT X + 2,Y + 7 TO X + 5,Y
      + 10 TO X + 11,Y + 8 TO X +
     9,Y + 30
520  HPLOT X,Y + 7 TO X - 3,Y + 1
     0 TO X - 7,Y + 9 TO X - 14,Y
      + 34
530  HPLOT X + 2,Y + 7 TO X + 5,Y
      + 10 TO X + 11,Y + 8 TO X +
     9,Y + 30
540  RETURN
550  REM  DRAW 5 TREES
560  FOR X = 1 TO 5
570 T =  INT ( RND (1) * 210) + 3
     0
580 C =  INT ( RND (1) * 120) + 5

590 XT(X) = T:YT(X) = C
600  HPLOT T,C TO T - 10,C + 10
610  HPLOT  TO T - 5,C + 10
620  HPLOT  TO T - 20,C + 20
630  HPLOT  TO T - 15,C + 20
640  HPLOT  TO T - 30,C + 30
650  HPLOT  TO T - 2,C + 30
660  HPLOT  TO T - 2,C + 35
670  HPLOT  TO T + 3,C + 35
680  HPLOT  TO T + 3,C + 30
690  HPLOT  TO T + 30,C + 30
700  HPLOT  TO T + 15,C + 20
710  HPLOT  TO T + 20,C + 20
```

```
720   HPLOT   TO T + 5,C + 10
730   HPLOT   TO T + 10,C + 10
740   HPLOT   TO T,C
750   NEXT X
760   RETURN
```

NOTES

Line 130: Calls the subroutine that draws 5 trees in a random pattern.

Line 140: Calls the subroutine that draws the skier.

Lines 160-190: This part of the program actually controls the entire game by calling the subroutines that check for input from the keyboard and move the skier. The program loops through these lines until the skier reaches the bottom or collides with a tree.

Lines 200-250: Check for input from the keyboard. The computer sets A$ equal to the key struck. If the key struck was A, Line 220 deducts 10 from SX. If the key was L, Line 230 adds 10 to SX. If the key was the Space Bar, Line 240 adds 6 to SY.

Line 220: CHR$(65) Returns the ASC11 character corresponding to the value of the argument, in this case A.

Lines 260-390: Move the skier to a new location. Line 270 checks for a location off the screen and resets X to the opposite side. Lines 260-280 check for a collision with one of the trees. The collision routine is called if the Y coordinate is between the top and bottom of a tree and the X coordinate is between the left and right of a tree.

Lines 400-420: Draw a + on top of the skier if he crashes into a tree.

Lines 440-540: Draw the skier.

Lines 550-760: Draw 5 trees at random locations.

SUMMARY OF APPLESOFT STATEMENTS AND FUNCTIONS USED IN THIS TEXT

Term	Definition	Example	Page First Used
CHR$	Returns the ASCII character corresponding to the value of the argument.	CHR$ (65) = A	115
COLOR	Sets the color for plotting in low-resolution graphics mode.	COLOR = 12 plots green	43
CONTROL	Used to interrupt a program while it is running.		90
COS	Returns the trigonometric cosine of the argument that must be in radians.	COS(2) = -.415	98
Cursor	The marker displayed on the screen that marks where the user's next action will take effect, or where the next character typed from the keyboard will appear.		15
DIM	Sets aside space for the array—here it is called A.	DIM A(20)	100
END	Causes the program to cease execution and returns control to the user.		33
FOR. . . NEXT	Allows you to repeat lines between the FOR and the NEXT statements.	FOR I = 1 to 20 NEXT I	23
GOSUB	Executes the subroutine that begins at the line indicated.	GOSUB 250	32

GOTO	Branches to line indicated.	GOTO 200	32
GR	Converts the display to low-resolution graphics mode with 40 columns and 24 rows.	GR	43
HCOLOR	Sets the display color for high-resolution graphics mode.	HCOLOR = 1 plots green	63
HGR	Converts the display to high-resolution graphics mode with 280 columns and 160 rows.	HGR	63
HGR2	Converts the display to high-resolution graphics mode with 280 columns and 192 rows.	HGR2	77
HLIN	Draws a horizontal line in low-resolution graphics, using the current low-resolution color. This example draws a line on row 5, starting at column 1 and ending at column 10.	HLIN 1,10 at 5	44
HOME	Moves the cursor to the upper left screen position within the text window and clears all text in the window.	HOME	15
HPLOT	Plots dots and lines in high-resolution graphics mode using the most recently specified value of HCOLOR. This example draws a line between the points (5,5) and (50,50).	HPLOT 5,5 at 50,50.	63
HTAB	Moves the cursor to the column specified. This example moves the cursor to column 23.	HTAB 23	28

IF . . . THEN	Executes or skips one or more statements, depending on the truth of the stated condition. In this example, IF A = 10 THEN line 200 is executed next. Otherwise the line after the IF . . . THEN statement is executed next.	IF A = 10 THEN 200	39
INPUT	Reads a line of input from the current input device.	INPUT A,B	38
INT	Returns the largest whole number less than or equal to the argument.	INT (9.5) = 9	38
PLOT	Plots a single block of the current display color at a specified position on the low-resolution graphics screen. This example plots a block at column 10, row 20.	PLOT 10,20	43
PRINT	Writes a line of output to the current display device. This example writes the value of A$, B, and C.	PRINT A$,B,C	14
REM	Includes remarks in the body of the program for the benefit of the user.	REM: THIS IS A REMARK	32
RETURN	Returns control from a subroutine to the statement following the GOSUB that called the subroutine.	RETURN	32
RND	Returns a random number between 0 and 1.	X = RND(1)	38
SIN	Returns the trigonometric sine of the argument.	SIN(2) = .90929	98
TAB	Positions the text cursor to a specified position on the output line during execution of a PRINT. This example moves the cursor to the column 23 of the current print line.	TAB(23)	32

TEXT	Converts the display to 24 lines of text, with the cursor positioned at the beginning of the bottom line.	TEXT	15
VLIN	Draws a vertical line in low-resolution graphics, using the current low-resolution color. This example draws a line down column 10 from row 1 to row 5.	VLIN 1,5 AT 10	44
VTAB	Moves the cursor to the line on the screen specified by the argument. This example moves the cursor to line 15.	VTAB 15	28

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